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The photograph seen in the cover page depicts the sunset at Nilaskal, Shimoga taken on winter solstice. Photo courtesy: Dr. Srikumar M. Menon.

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Astronomy in Vedic texts

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1 Introduction

Astronomy in popular perception is about stars, planets, the sun, the moon, eclipses, comets, meteorites and associated observable phenomena. Something of all of these was known to our ancients though not in the same form and detail as it is available now. In the context of India, the question is what was known, in what detail and when. For the *siddhānta* period, roughly starting with the common era, (CE) such questions have been fairly well answered. This has been possible since several texts of the period, specifically devoted to astronomy are available for systematic study. But for the more ancient period we have no exclusive texts other than Lagadha's *Vedāṅga Jyotiṣa* (ca. 1400 BCE) which is a calendar with no reference to eclipses or planets. Hence when one talks of Vedic Times several precautions are necessary. Firstly even though for the *pre-siddhāntic* period many texts are available, they are neither specific to astronomy nor are they by particular authors. Second, the texts were all orally transmitted by memory for generations before they were scripted on palm leafs. This knowledge tradition has come down to us mainly in Sanskrit. Three broad classes of BCE texts can be identified namely Vedic, Purāṇic and Śāstric. Texts of the first group including the ancillaries such as the *Sūtras* and the *Pariśiṣṭas* are preserved unchanged in their original form with practically no variation with time. The same cannot be said about the two epics, the eighteen and more *Purāṇas*, *Saṃhitās* of Parāśara and Vṛddhagarga which have undergone changes in common era also. Texts on grammar, prosody, dramas of Bhāsa, Kauṭilya's *Arthaśāstra*, Bharata's *Nāṭyaśāstra*, Jaina and Buddhist literature making up the third group are relatively late. But these

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also provide insights into Indian astronomy before the common era. In addition to the above clarification, it is essential to bear in mind the time frame of development of the above class of literature which spans some three to four thousand years starting from an unknown past to the first millennium BCE. Hence we have to also address the question of chronology consistent with whatever verifiable information that can be found.

It is generally observed that Vedic culture personified celestial objects and their actions. Hence the texts carry a background that has to be deciphered for extracting the archaic models of the visible sky. When we read that a demon (*asura*) fell from the sky and went underground, we can safely infer that this picture should have been probably correlated in time and space with a meteorite fall. Similarly when it is said that an *asura* covered the sun, we may suspect this event to be an eclipse. This allegorical approach was known to the Vedic tradition as recorded by Yāska (ca. 700 BCE) who records three types of interpretations for several hymns of the *Ṛgveda*. These are the *adhiyajña, adhyātma* and the *adhidaiva;* the sacrificial, philosophical and celestial (divine) meanings respectively. For example the *adhidaiva* meaning of the word Soma is the moon, whereas in a Vedic sacrifice as per the *adhiyajña*, Soma is a creeper of that name. In the *Upaniṣads* the philosophical meaning of Soma is *manas* or mind. The *Śatapatha Brāhmaṇa* (ŚB) has the esoteric statement:

चन्द्रमा वै सोमो देवानामन्नम्। ता पौर्णमास्यामभिषुण्वन्ति॥ (ŚB. 11.1.5)

Moon is Soma the food of gods; they approach him on the full moon day.

But, Yāska quite clearly says in the *Nirukta* (11. 4-5) that Soma is the moon whom no gods literally eat. It is easy to see that the reference in such cases is to the waning moon said to be consumed by gods on a daily basis starting from the full moon. The Vedic seers personified celestial objects as they beheld some cosmic transcendental unity and pattern through observable natural phenomena. Hence it should not be surprising to find in Vedic sacrifices, Hindu religion and *Vedānta* philosophy reflections of ancient sky pictures, however hazy they might seem now. This type of modelling sky observations by our Vedic ancestors can be called scientific naturalism. The sky descriptions become more interesting especially when numbers are associated with the celestial divinities. In the following four sections we investigate briefly how comets, meteorites, and eclipses were experienced and pictured in the Vedic texts. Over a long period of time the effect of precession was also felt as with the loss of importance for the constellation *Śiśumāra* (Draco) and shifting of the pole star *Dhruva*. The astral descriptions and the religious lore behind the above astronomical entities provided the inspiration for the development of observational and mathematical astronomy in India.

Some portion of the present study has appeared in the Indian Journal of History of Science (2005, 2009, 2010, 2011 and 2012) in the form of papers.

However, considerable new information, beyond the published material, can be found in the following pages.

2 Comets and meteorites in the *Ṛgveda*

The *Ṛgveda Saṃhitā* is the most ancient literature of India available for our study. The three other *Vedas* namely the *Yajurveda*, *Sāmaveda* and the *Atharvaṇaveda* along with their ancillary texts are closely linked to the *Ṛgveda* in several ways. The remote antiquity of the *Ṛgveda* and the live tradition of oral transfer of the *Vedas* by complex linguistic artifices are evidences for the utmost importance attached by Hindus in preserving the original information as precisely as possible. It is an attested fact that even after several millennia, *RV* containing 10 books (*maṇḍala*) with 1028 hymns (*sūkta*) totaling 10552 verses (*mantra*) is learnt and recited with exactly the same content and sequence all over India. This is the primary source for finding the most ancient celestial observations made in the Indian skies. Even though *RV* is not a book on astronomy or on natural sciences, it is a collection of hymns covering a large variety of themes ranging from the physical to the spiritual, human to the superhuman, religion to philosophy, individual to the collective, earth to the sky to the universe. It spans several centuries in its compositional spread and represents a wide area of land also in its coverage with names of rivers, mountains, lands and lakes. The language of *RV* is by definition, Vedic Sanskrit and its style can at best be described as inspired poetry emanating out of spontaneous intuition, revelation or contemplation. Hence explaining the text strictly through analytical methods of grammar, etymology, dictionaries and linguistics will make us miss the forest for the trees.

Any one approaching the *RV* faces the daunting problem of extracting the meanings of the hymns. This difficulty is known since the time of Yāska who already noted that *RV* hymns can be interpreted in several different ways. Due to the archaic nature of the Vedic language, precise meanings may remain unknown, but the overall contextual implications when read with other similar hymns should be reasonably clear. Hence when a particular event or deity is described more number of times, a clear picture of what the ancient composers meant emerges. To approach the *RV* in this fashion, we have to follow the ancillary texts and the traditional Sanskrit commentaries, instead of going by modern day translations. This helps us to find whether the origin of a later Vedic ritual can be traced to the sky pictures of the *RV*. Among the various editions of the *RV* available, the Mysore Palace edition of the *Ṛgveda* (*abbr. MPRV*) is versatile.[1] This gives in thirty six volumes an exhaustive

[1] *Ṛgveda Saṃhitā*; edited by a group of ten scholars, published by the Mysore Palace, 1950. This thirty-six volume series in Kannada script is complete with *Saṁhitā* and *Pada Pāṭha, Khila, Sāyaṇa's* commentary, *Anukramaṇi, Ṛgvidhāna, Aitareya Brāhmaṇa*, the *Bṛhaddevatā* and the *Nirukta* with elaborate traditional explanations which are indispensable to follow *RV*.

introduction, the text, traditional meaning, ritual application, grammatical explanation, and the complete Sanskrit commentary of Sāyaṇa along with the ancillary texts needed to follow the *Ṛgveda*. The translations and interpretations of the hymns given here follow closely the commentary of Sāyaṇa and the traditional explanations given by the compilers of the *MPRV* edition.

2.1 Description of *Dhūmaketu* in *Ṛgveda*

There are several RV hymns that employ the word *dhūmaketu*. Hymn (I.27) starts comparing *agni* to a tailed horse.

अश्वं न त्वा वारवन्तं वन्दध्या अग्निं नमोभिः। सम्राजन्तमध्वराणाम्॥ (I.27.1)

In the second verse of the hymn this object is qualified as having wide motion (*pṛthupragāmā*). In the sixth verse this *agni* is called *citrabhānu*, that is one having varied colors. This fire is qualified in the tenth verse as *rudra*, one with ferocious form. This is followed by a prayer with a specific name for the fire in question.

स नो महान् अनिमानो धूमकेतुः पुरुश्चन्द्रः। धिये वाजाय हिन्वतु॥ (I.27.11)
May the great, illimitable, brilliant *dhūmaketu* (smoke-bannered) be pleased with our rite and inspire us.

MPRV aptly points out that there can be no special similarity between *agni* and a tailed horse as in this hymn, even as a figure of speech. The hymn is clear that the object of its attention is stationed in the sky. If this *agni* were to have a tail, have perceptible movement, be large without specific measure (*mahān animāno*) and look like a big bright celestial herald (*viśpatiḥ daivyaḥ ketuḥ bṛhadbhānuḥ* | v.12) it could as well have been a comet described aptly by the word *dhūmaketu*. The epithet *viśpatiḥ* signifies the object to be closely connected with *maruts*, who are called *viś* in the RV. This point will be considered later.

Next we come across this word in a hymn by Praskaṇva of the Kaṇva family to which belong the authors of the eighth book.

अद्या दूतं वृणिमहे वसुम् अग्निं पुरुप्रियम्।
धूमकेतुं भाऋजीकं व्युष्टिषु यज्ञानाम् अध्वरश्रियम् ॥ (I.44.3)
We choose today at day break as messenger the good *agni*, the beloved of many, the smoke-bannered, who shines with his brightness and who is the protector of the doer of sacrifice.

Here the action of selecting *agni* as messenger (*dūtam*) is in the first person. This *agni* is qualified as *dhūmaketu* and *bhārjika*. The word *bhārjika* means 'shining' according to *Yāska*[2]. This may mean one who is shining or may mean one who is famous as *Bhā*. This *agni* is addressed in (v.4) as guest (*atithi*), highlighting his transient nature. In (v.10) *agni* is referred also as *purohita*

[2] भाऋजीकः प्रसिद्ध-भाः। धूमकेतुः समिधा भाऋजीकः इत्यपि निगमो भवति॥ *Nirukta* (6.4)

and as *vibhāvasu* who had shone previously at many dawns (*pūrvā anu uṣaso vibhāvaso didetha*). MPRV interprets *purohita* traditionally as,

> one (the fire) who is installed in the east of the sacrificial altar in the *āhavanīya* pit.

This hymn ends in (v.14) with a request to the fire-tongued *maruts* to be heard (*śṛṇvantu marutaḥ agnijihvāḥ*). This hymn appears to be closely related with hymns of the 8th book of RV. The transient nature of the fire, named *vibhāvasu* or *bhā* with links to *maruts*, amply hints at this object to be a comet. As per the MPRV explanation, this hymn is an invocation to the celestial agni, the comet deity, already deified from previous tradition[3].

2.2 Description of *Maruts* in the *Ṛgveda*

As is known Agni and Indra are the most important deities in the *RV*. This is true, not only in a statistical sense, but also in terms of the importance they have carried in the Vedic rituals and literature devoted to the elucidation of the *RV*. Even though the original agni of the *RV* was clearly celestial, the terrestrial sacrificial agni assumed greater significance in the traditional (*yājñika*) interpretation of the *RV* by Sāyaṇa and others before him. The reason for this is not difficult to find. The Vedic religion of *yajña* on earth is a replica of what the gods did once upon a time. This *yajña* of the gods was of celestial origin with its effects reaching the earth. Hence, this was of profound spiritual significance to the originators of Vedic religion and philosophy, to raise questions about the place of man in the universe culminating in the *Vedānta* and the *Upaniṣads.* There are several instances in the *Vedas* where this point is stated either metaphorically or even directly. In the second book (II. 21.5), *Uśij*s (*Aṅgiras*) are said to have found the path by means of *yajña.* The allegorical reference is to the overthrow of *vala* to get the waters released. The *RV* hymn (VIII. 89) by Nṛmedha and Purumedha (Aṅgiras) is about Indra supported by *maruts* as a group. In this hymn the principle of *yajña* is said to have originated when Indra spread between the earth and the sky for killing Vṛtra. This *yajña* of gods had a corresponding sacrifice on earth also, which in modern parlance could be called a natural disaster. *Maitrāyaṇī saṃhitā* mentions that gods did a sacrifice at Kurukṣetra.[4] This is confirmed with further elaborations in the *Taittirīya Āraṇyaka.*[5] *Taittirīya Brāhmaṇa* categorically states, *maruts* killed Prajāpati's creatures because they (*maruts*) were not initially worshipped by the people. Prajāpati (progenitor of people) had to behold a particular offering and present it to *maruts* in order to save his

[3] For other references in the Ṛgveda and more detailed discussion on *Dhūmaketu*, the reader is referred to Indian Journal of History of Science (IJHS) articles (2005, 2009, 2010, 2011 and 2012).

[4] देवा वै सत्रमासत कुरुक्षेत्रे॥ *Mai. Saṃ.* (IV. 5.9)

[5] देवा वै सत्रमासत...तेषां कुरुक्षेत्रं वेदिरासीत्। तस्यै खाण्डवो दक्षिणार्धमासीत्। तूर्घ्नमुत्तरार्धः। परीणङ्घनार्धः। मरव उत्करः॥ *Tai. Āra.* (5.1.1)

creation.[6] A similar statement occurs in the same text about *maruts* disturbing the work of Prajāpati.[7] Since the *RV* is the earliest among the *Vedas,* other texts derive inspiration from the *RV* for their contents and practices. Thus Vedic literature has evidence to infer the sacrifice by the gods through the agency of meteoritic storms, called *maruts* in the *RV*, which have depleted population in the northern parts of ancient India.

The present study started by tracing the word *dhūmaketu.*[8] In the sequel *maruts* and *vibhāvasu* were found to be intimately connected with the fiery *dhūmaketu. Vibhāvasu* could be the name of one or more comets but the evidence is equivocal. It is possible this word was used in some hymns as a qualification for Agni, which depending on its location was called by different names. In one place significantly, *vibhāvasu* is said to be like a big rock (v. 25.8) making one surmise, that the ancients had guessed the basic nature of these near earth objects, sometimes called deities but at other instances as demons, correctly. It is *maruts* that get more space than the other two objects considered here, almost competing with Indra and agni with whom they are any way closely related. The minimal commonality in the physical feature of *maruts,* is their countable membership to a group (*gaṇa*), unlike undifferentiated masses of clouds or sheets of water. The *Brāhmaṇa* texts explain that *maruts* are *viś;* the groups (or clans) and this means their abundance in the skies.[9] The perception of the *RV* composers (I. 27.12) was that as in their community traders and agricultural people (*viś*) were in abundance, so were maruts abundant in the sky. The *Taittirīya Brāhmaṇa* declares this explicitly; *maruts* are the most numerous among the gods.[10]

Three broad phases can be discerned in the description of *maruts.* The first, probably the earliest in time, are hymns which express awe at the approach of *maruts.* These also express a sense of fear that *maruts* are prone to kill people on earth. In the second group are prayers so that the shower of stones may avoid the worshippers of *maruts.* The third layer contains hymns wherein *maruts* are invoked to come to prayer or worship. It may not be wrong to conjecture that this trend should have been directly matching with the frequency of the storms of *maruts.* We also find hymns in which *maruts* are prayed to bring medicines and precious materials (*sanāddhi vo ratnadheyāni santi* | X. 88.8). This should be a later view of *maruts* after physical examination of the falling objects and a feel for their contents. A point to be reconciled is

[6] संवत्सरो वै प्रजापतिः। संवत्सरे एवास्मै प्रजाः प्राजनयत्। ताः प्रजा जाता मरुतोऽघ्नन् । अस्मान् अपि न प्रायुक्षतेति। स एतम् प्रजापतिर्मारुतं सप्तकपालम् अपश्यत्। याः पूर्वाः प्रजाः असृक्षि। मरुतस्ता अवधिषुः॥ *Tai. Brā.* (I. 6.2.2-3-4)

[7] मरुतो यज्ञमजिघान्सन् प्रजापतेः॥ *Tai. Brā.* (I. 3.4.4)

[8] The term literally means 'the one who is smoke-bannered' `` धूमः केतुः यस्य सः ।"

[9] विशो वै मरुतो भूमो वै विट्॥ ŚB. (III. 9.1.17); मरुतो हि वै देवविशः अन्तरिक्ष भाजनाः॥ *Kauṣītaki Brā.* (7.9.16):

[10] मरुतो हि देवानाम् भूयिष्ठाः॥ *Tai. Brā.* (2.7.10.1)

the meaning of *maruts* as wind deities in later literature. We guess that with the status of Indra getting downgraded in time to a mere rain god, *maruts* always linked with Indra, were also brought down as wind deities. This has happened notwithstanding the fact *parjanya* and *vāyu* are the independent rain and wind deities in the *RV*.

The later Vedic texts corroborate the above points, since they essentially describe invocations and offerings to *maruts*. The *Taittirīya Āraṇyaka* which, states that *maruts* were in abundance and killed people, also states that there is only one Rudra and the innumerable thousands (Rudra's children) are not seen any more but only remembered.[11] It also associates a season with *maruts*, namely the *hemanta ṛtu* (the dewy season) which is the two month period ending with the winter solstice.[12] It is most likely that *maruts* were thought to originate from a particular object in the sky, called Rudra. In many hymns of the *RV maruts* are the children of Rudra, and their downward gliding motion is described by the unique word *skandanti* from which the proper name *Skanda* has originated. It is noted here, that not in all Vedic literature *maruts* are denoted as Rudra's children. The *Taittirīya Āraṇyaka* differentiates *rudragaṇa* from *marut-gaṇa* and mentions that the first appear in the *grīṣmartu*, the two month season ending with the summer solstice before the rainy season starts. The latter appear in the *hemantartu*, as in the *Taittirīya Brāhmaṇa.* The commentators mention that both are sky deities appearing in their respective seasons. *Rudragaṇa* is described as being white robed and recurring with the summer season.

विशेषणं तु वक्ष्यामः। ऋतूनां तन्निबोधत। शुक्लवासा रुद्रगणः।
ग्रीष्मेणावर्तते सह। निजहन् पृथिवीं सर्वाम्॥ *Tai. Āra.* (1-3-3).

The second group appears red with anger as though ready for battle in the dewy season.[13] It is easily recognized that both are meteor groups separated by six months. This again makes a case for ancient sky observations and earthly rituals going hand in hand. It also hints at the development of observational astronomy starting with the identification of seasons, connected with the observable meteor showers, which once should have caused destruction on land. This raises the question whether *maruts* was a generic word for all types of meteoritic activity or it referred to particular types. This cannot be answered definitively at present. *Ulkā* the popular word for meteorite in

[11] य एको रुद्र उच्यते। असङ्ख्याताः सहस्राणि। स्मर्यते न च दृश्यते॥ *Tai. Āra*, (I. 12.1)
[12] हेमन्तर्तुना देवाः। मरुतस्त्रिणवे स्तुतम्॥ *Tai. Brā.* (II. 6.19.2)
[13]

अभिधून्वन्तो अभिघ्नन्त इव। वातवन्तो मरुद्गणाः।
अमुतो जेतुमिषुमुखमिव। सन्नद्धाः सह ददृशे ह।
अपध्वस्तैर्वस्तिवर्णैरिव। विशिखासः कपर्दिनः। अक्रुद्धस्य योत्स्यमानस्य। क्रुद्धस्येव लोहिनी।
हेमतः चक्षुषी विद्यात्। अक्ष्णयोः क्षिपणोरिव॥ *Tai. Āra.* (I. 4.2)

classical Sanskrit is already in use in the *RV*. This word in plural occurs in IV. 4.2 where *agni* is asked to cast his firebrands (meteors) around. Again *ulkā* appears in the singular in X. 68.4 where a meteor is said to be cast down from the sun. The group nature that is special to *maruts* is absent in the occasional meteor called *ulkā*. It is not the case that the composers of the 4th and the 10th books were not aware of *maruts*. But they deliberately brought in a new word to discriminate *maruts* from other transient falling objects. The *Ṣaḍvimśa Brāhmaṇa* further brings in new terminologies and events *tārā-varṣa* or star showers, and *dig-dāha* meaning blaze of the cardinal directions or zodiacal light in addition to *ulkā* and *ketu*.

2.3 Modern concepts

Only a small sample of the *RV* hymns are investigated in the present study. But, if the events described in these were descriptions of real events, either by direct experience or based on family tradition, the situation would indicate the occurrence of an ancient natural disaster attributable to meteoritic showers, comets, dust veils and climate alteration for an extended length of time. Evidence for such a severe natural disaster to have occurred in ancient India is available also in the *Mahābhārata* and the *Skandapurāṇa*.[14]

In recent years scientific evidence for near earth objects to have impacted earth in the past has been growing. The path of the Taurid group of extra terrestrial objects consisting of meteors, meteoroids, asteroids and Comet Encke intersect the orbit of the earth making earth vulnerable for impacts from these objects. Some of these objects instead of reaching the ground may vaporize in the atmosphere leading to air blasts and fires as it happened in Tungska, Siberia in 1908. It is held by astronomers that in the last 10,000 years Comet Encke split and further disintegrated to leave a trail of debris which caused dust veils that would have temporarily blocked the sunlight reaching earth.[15] Thus, the Ṛgvedic descriptions of *maruts* killing people on earth, birth of *agni* and the Horse in the sky, *vṛtra* covering the sun, Indra restoring the sunlight, breaking down of *viśvarūpā* son of *tvaṣṭā* and celestial deities coming down to earth (India) to become important in cultural and religious practices, are to be taken as natural events of low probability but not impossible to have happened in the fourth millennium BCE or earlier.

2.4 Chronological footprint

The relatively late usage of the word *dhūmaketu* in the *RV* has chronological significance for understanding the development of astronomy in ancient India.

[14] *Profile of a natural disaster in ancient Sanskrit literature.* By R. N. Iyengar; Indian Journal History of Science, 2004; 39.1. pp. 11-49.

[15] The Cosmic Winter. By Clube and Napier; Basil Blackwell; U. K. 1990., Rogue Asteroids and Doomsday Comets. By D. Steel J. Wiley & Sons New York, 1995.

The word *dhūmaketu* for a transient celestial object in the *RV* and in the *AV* is in harmony with the use of the word to indicate a comet in later literature. This acquires significance since, names of some of the Vedic deities (*devatā*) coincide with the names of comets and other non-planetary objects described by Parāśara, Vṛddhagarga, Nārada and Devala who have left records of what may be called scientific literature prior to the development of mathematical astronomy in India.[16] Parāśara knew twenty six comets (*ketu*) long before Varāhamihira (6th cent. CE) stated them in the wrong order in his *Bṛhatsaṃhitā.* The last comet of this list was called the *dhūmaketu.*

The most conservative dates for the *RV* agree that the canons were closed, including the late 8th and the 10th books, by 1500 BCE. This, situation not only supports the deciphering of some *RV* deities as transient celestial objects, but also indicates the existence of a parallel tradition of sky observations contemporaneous with what is mentioned poetically in the *RV*. Parāśara and subsequently Vṛddhagarga had more things to say about comets. These conspicuously included their specific names, year number, and position in the sky, movement, color, visibility, duration, and effect on earth. They also classified meteors (*ulkā*) into five types. Parāśara and Vṛddhagarga mention that a *graha* (grasper) called *Tvaṣṭā* can darken the sun and the moon at odd times. Varāhamihira, a votary of mathematics for predicting eclipses, severely criticizes Parāśara for his eclipse divination methods, but retains the above legend in his writings. We conjecture that strong belief in the historical reality of such a rare event should have been in the collective memory of the community since the start of the *Ṛgveda,* for Varāhamihira to accept its possibility and retain this event in the *Bṛhatsaṃhitā.*

Interestingly, *maruts* and correlated sky objects do not refer to the moon directly. References to the moon, months, intercalation, eclipses probably belong to another strata of the *RV* coming after the havoc caused by *maruts* and the consequent climate alteration effects subsided. It is as if the original group of people left their memories of a divine (celestial) catastrophe in poetic language upon which their successors added further observation of the sky leading to lunar and solar rituals. An algorithmic calendar attributed to Lagadha became a necessity for timing the rituals. The *Ṛgveda* is well aware of eclipses and their recurrent nature. This is in contrast to the sun getting veiled due to atmospheric dust or a trail of comet debris. While the observation of a solar eclipse by Atri is easily recognized, lunar eclipses are metaphorical invoking agni to a *yajña* when the moon appears red in colour. The number 3339 mentioned twice in the *RV* is explained by the *Brahmāṇḍapurāṇa* unambiguously as a lunar number. This symbolic connection between the above Ṛgvedic number and the eighteen year eclipse period is discussed in the following section.

[16] Iyengar R. N., *Archaic Astronomy of Parāśara and Vṛddhagarga,* IJHS 43.1, pp. 1-27, 2008.

3 Eclipse cycle number 3339 in the *Ṛgveda*

In the *RV* we come across many small numbers and also a few fairly large numbers. The small ones such as 3, 7, 12, 27, 49, 360 can be explained as having some physical significance and are also easily countable. A notionally large number appearing in a sacred text due to chance is more apt to be in hundreds and thousands in round figures. Curiously enough 3339 is a large number but is too precise and specific to be taken as an arbitrary count of *Viśvedeva* (VD) due to chance. What could be the connection of this number 3339 with the eclipses and VD is the subject matter of investigation in this section.

3.1 Description of eclipses in the *Ṛgveda*

Eclipses of the sun and the moon must have been experienced by the Vedic people as they became consciously sensitive to the visible sky. The codified *darśa-pūrṇamāsa* rite, observed to this day by some *āhitāgnis*, indicates a fairly sophisticated stage when time reckoning and the calendar had become important. Between such practices and the ancient worship of *maruts* with invocations to celestial fires, what can we infer about possible eclipse observations described in *RV*? This question is not simple to answer, since the word *rāhu* so common in later literature does not appear in the *RV*, in stark contrast to the word *ketu* that appears eighty times. The first reference to *rāhu* by name is in the *Atharvaveda* where the moon, planets, meteors, *rāhu* and the *dhūmaketu* are mentioned together.[17] Thus, at least by the time of compilation of the *Atharvaveda* the Vedic community had differentiated the actions of *rāhu* and *ketu,* as agents capable of masking the celestials. In the later texts of Parāśara, Garga, the two epics and classical Sanskrit literature, *rāhu* modeled as a large dark planet is taken as the cause of both solar and lunar eclipse. In the *RV* the well recognized solar eclipse is attributed to *svarbhānu* but description of lunar eclipse is not easily recognizable in the text. In hindsight this is only natural, since in contrast to the darkening of the sun, the moon appears red in a total eclipse. Thus for the earliest Vedic observers it was natural to postulate two different obstructing agents for the day time and night time events.

The covering of the sun by *maruts,* stopping of the chariot of the sun and the many prayers for restoration of sun's light cannot be taken as references to solar eclipses. The predominant action of *vṛtra* was prolonged masking of the sunlight, whereas any solar eclipse could have been for comparatively very short durations. However, the word *vṛtra* can be interpreted as one who covers and since it is said that he was won over by Indra, the same imagery might have been used in the early periods to describe solar eclipses also. Usage of

[17] शं नो भूमिर्वेप्यमानः शमुल्काहतञ्च यत्। ...शं नो ग्रहाः चान्द्रमसाः शमादित्यश्च राहुणा। शं नो मृत्युर्धूमकेतुः शं रुद्राः तिग्मतेजसः॥ (XIX. 9.7-10).

the same word to denote two distinct objects can be reconciled when one can attribute the same type of action to the two objects. As is known *vṛtra* is the archetype *asura* or demon in later *Purāṇa* legends. We infer that a negative meaning for the word *asura* had gradually gained acceptance during the *RV* period itself, as someone who could obstruct celestial objects. This is reflected in the legends about *maruts* that they once killed the children of Prajāpati because they were not respected. Conversely those venerated by people were known as *asura,* who could discharge stony weapons towards earth. The homonyms *asurā…pūrvadevā suradviṣaḥ* listed in the *Amarakośa* support this conclusion.[18] The word *sura* in the sense of deva or a deity is not found in the *RV*. The popular interpretation of *asura* as the opponent of *sura* is a later development in the *Brāhmaṇa* texts. However, in some places in the *RV*, *asura* are in conflict with *deva* the celestial luminaries of the *adhidaiva* meaning. Thus it should not be surprising to see *asura* being described as personified dark objects in the sky. In fact we find the word *asura,* that is used to refer to *maruts* in the *RV*, is also used directly or in a derivative form while describing eclipses. We see that in such cases the composers might have referred to the past actions of *asura* covering the sun or some other luminary. This situation no doubt brings in some ambiguity in locating references to eclipses in Vedic literature, except when the statements are explicit and hence cannot be taken otherwise.

3.2 Solar eclipse

Indian tradition takes the *RV sūkta* (v. 40) to be the description of a solar eclipse. Modern authors also agree with this explanation. It will be interesting to briefly review the contents of this hymn to appreciate the epithets and terminologies used.

यत्त्वा सूर्य स्वर्भानुस्तमसा विध्यदासुरः।
अक्षेत्रविद् यथा मुग्धो भुवनान्यदीधयुः॥५॥
स्वर्भानोरध यदिन्द्र माया अवो दिवो वर्तमाना अवाहन्।
गूळ्हं सूर्यं तमसाऽपव्रतेन तुरीयेण ब्रह्मणाऽविन्दद् अत्रिः॥६॥
मा मामिमं तव सन्तं अत्र इरस्या द्रुग्धो भियसा नि गारीत्।
त्वं मित्रो असि सत्यराधास्तौ मेहावतं वरुणश्च राजा॥७॥
ग्राव्णो ब्रह्मा युयुजानः सपर्यन् कीरिणा देवान् नमसोपशिक्षन्।
अत्रि:सूर्यस्य दिवि चक्षुराधात् स्वर्भानोरप माया अघुक्षत्॥८॥
यं वै सूर्यं स्वर्भानुस्तमसाऽविध्यदासुरः।
अत्रयस्तमन्वविन्दन् न ह्यन्ये अशक्नुवन्॥९॥ *RV* (5.40. 5-9)

O Sun! When *svarbhānu* the *āsura* struck you with darkness the worlds became like a person not knowing where he stood. (5)

[18] असुरा दैत्यदैतेयदनुजेन्द्रारिदानवाः।
शुक्रशिष्या दितिसुताः पूर्वदेवाः सुरद्विषः॥ (*Amarakośa* I. 1.12)

> O Indra! While you were removing the illusions of *svarbhānu* that spread below the sun, Atri by his fourth prayer rescued the sun concealed by darkness. (6)
>
> Let not the violator devour me with darkness. You are Mitra whose wealth is truth. Let you and King Varuṇa protect me. (7)
>
> Then, Atri bringing the stones together, offering prayers to deities dispelled the darkness and placed the eye of the sun in the sky. (8)
>
> Only the Atris and none others, could subsequently find the sun whom *āsura svarbhānu* struck with darkness. (9)

Several pieces of interesting information can be gathered from the above hymn. The above verses (5–9) are part of a larger hymn that addresses Indra. Even though the event is popularly known as Atri's eclipse, it is Indra who is said to have removed *svarbhānu.* The sun prays to Atri along with Mitra and Varuṇa seeking protection. After this, it is said that Atri placed the sun in the sky. The 9th verse is somewhat unconnected with the previous verses since it refers to the family members of Atri and not to any specific Atri. The eclipse shadow called *svarbhānu* has the epithet *āsura*, which is popularly rendered as *demon.* But from what we found in the previous section *maruts* were the original *asuras* who could throw stones at earth. They had also covered up the sun once. However, in the *RV* this word has other positive connotations as being powerful and at times even as divine. Here in the hymn *RV* (v. 40) we see the evolution of the concept of an obstruction being called *āsura* a derivative of *asura* who had to be removed by Indra. This clear link between *āsura* and eclipse shadow indicates that wherever the word *asura/āsura* appears one has to investigate whether or not any metaphorical picture of an eclipse is embedded in the hymn. The above event is also the traceable textual source for the legend of *rāhu* equated with *svarbhānu* being known as an *asura* in later literature. The word *asura* in the *Purāṇas* is more in the sense of an enemy of *sura* who in turn are equated with gods or regent deities. As already noted *rāhu* the eclipse causer appears in Vedic literature first in the *Atharvaveda.* Since *svarbhānu* is *āsura,* with tenuous connection to *maruts,* the word *rāhu* is likely to be a short form of the epithet *varāhu* used for *maruts* in the *RV* (I. 88). After a few more hymns in the same book we read in (v. 49.2):

> प्रतिप्रयाणम् असुरस्य विद्वान् सूक्तैर्देवं सवितारं दुवस्य।
> उप ब्रुवीत नमसा विजानन् ज्येष्ठं च रत्नं विभजन्तमायोः॥
> Knowing the *asura's* time of returning, worship the deity Savitar with hymns and praises.

This verse uses the technical word, *prati-prayāṇam,* which means return journey or travel. Reference to the return journey of *asura* and worship of the sun leaves one wondering whether this pertains to an expected solar eclipse. This hymn has *viśvedevāḥ* as its deities, in common with several other hymns yet to be considered that carry some type of eclipse imagery.

3.3 *Viśvedevāḥ* (VD)

The group of deities known as *viśvedevāḥ* is of considerable importance in Vedic literature and also in Hindu religious observances. It has been the practice to translate this word as All-gods, which hardly conveys the role of these deities in the *Vedas.* A brief review of the traditional stand on these deities is important for our further analysis, since *viśvedevāḥ* (VD) were also countable like *maruts.*

In the *RV* apart from many isolated verses there are fifty-eight independent hymns devoted to VD. What was the role of VD in the Vedic world view? On this point, there is difference of opinion among the later texts and commentators. In one place in the ŚB it is said VD created the directions.

विश्वेदेवाः वैश्वनरा दिशः कृत्वा तास्वेतां आशिषमाशासत॥ ŚB. (6.5.2.6)

However, in another place they are described as the seasons.

ऋतवो वै विश्वेदेवाः तदेनां विश्वैर्देवैः ऋतुभिः संविदानः॥ ŚB. (7.1.1.43)

The attributes and actions of VD are varied, but are almost always connected with time and space and hence important in our study. *Bṛhaddevatā* (BD) of *Śaunaka* an explanatory text describing the legends, organization, numbers, and actions of the *RV* deities, is indispensable in the study of the *RV.* As per BD the eleven hymns starting with (v. 41) in the 5th book of *RV* are devoted to VD.

को नु वां वैश्वदेवानि एकादश पराण्यतः॥ (BD. 5.36).

According to BD (1. 136) all the Vedic deities structured into three subgroups taken together are known as *viśvedevāḥ.* The hymns about VD are also classified into three groups (BD 3.42). A list comprising of both individual deities and several sub-groups is given in BD, as making up the full VD group.

सप्तर्षयो वसवश्चापि देवा अथर्वाणो भृगवः सोमसूर्याः।
पथ्या स्वस्ती रोदसी चोक्तमन्त्रे कुहूर्गुन्गूरदितिर्धेनुरघ्न्या॥
असुनीतिरिला चास्या विधातानुर्मतिर्ह या।
अङ्गिरोभिः सहैताः स्युः उक्तमन्त्राश्च देवताः॥
वैश्वानरो हि सुपर्णो विवस्वान् प्रजापतिद्यौः सुधन्वा नगोह्यः।
अपाम्नपादर्यमा वातजूतिरिलस्पतिश्चापि रथस्पतिश्च॥
ऋभवः पर्जन्यः पर्वता ग्नाश्च दक्षो भगो देवपत्नीर्दिशश्च।
आदित्या रुद्राः पितरोऽथ साध्या निपातिनो वैश्वदेवेषु सर्वे॥ BD (8.125-128)

BD also provides names of some forty *RV* seers who had understood or realized the nature of *viśvedevāḥ.*[19] But, the hymns assigned to many of these seers are found to be about *agni.* The explanation of the Vedic tradition for this

[19] मेधातिथिरगस्त्यस्तु बृहदुक्थो मनुर्गयः। ऋजिश्वा वसुकर्णश्च शार्यातो गोतमो लुशः।
स्वस्त्यात्रेयः परुच्छेपः कक्षीवान् गाथिनौर्वशौ। नाभाकश्चैव निर्दिष्टो द्युवस्युर्ममता सुतः॥
विहव्यः कश्यपऋषिः अवत्सारश्च नाम यः। वामदेवो मधुच्छन्दाः पार्थो दक्षसुतादितिः॥ BD (3.55-60)

apparent anomaly is: when *agni's* cosmic actions are described, such a hymn refers to VD.

आग्नेयं सूक्तमैभिर्यद्वैश्वदेवं इहोच्यते। तद्विश्वलिङ्गं गायत्रं वैश्वदेवेषु शस्यते॥ (BD 3.33).

What was this special cosmic action of *agni* which took the *Vedic* seers beyond meteors, comets, lightning and the sun that further necessitated a set of countable deities? The answer to this question is also available in the *Bṛhaddevatā*.

स्वर्भानुदृष्टं सूर्यस्य अपहत्य ततोऽत्रयः। सप्तविंशतिभिः सूक्तैः अबोधीत्यग्निमस्तुवन्॥ (BD. 5.12)
The seers of the Atri family, for removing the ill effect of the sun who was seen (covered) by *svarbhānu,* woke up *agni* with twenty-seven hymns.

Thus as per the orthodox tradition all the twenty-seven hymns of the fifth book devoted to *agni* have some connection with eclipses. One can easily suspect that this relation between a solar eclipse and *agni,* other than indirectly indicating that the sun was recognized as a form of fire, should have been through a connection between VD and *agni.*

About the total number of deities recognized by the *RV* there is difference of opinion among the commentators. As per the *Nirukta* even though there are only three natural deities localized to earth, atmosphere and sky, due to their separate activities the deities are named severally.

तिस्र एव देवता इति नैरुक्ताः। अग्निः पृथ्वीस्थानः। वायुर्वा इन्द्रो वा अन्तरिक्षस्थानः।
सूर्यो द्युस्थानः। तासां महाभाग्यात् एकैकस्यापि बहूनि नामधेयानि भवन्ति।
अपि वा कर्म पृथक्त्वात्॥ *Nirukta* (7.5)

According to this logic still larger numbers can be recognized depending on the multiplicity of actions assigned to the *RV* deities. In *RV* (I .34.11) the two *aśvins* are invoked to arrive along with the thirty-three deities.

आ नासत्या त्रिभिः एकादशैः इह देवेभिः यातं मधुपेयं अश्विना। *RV* (I. 34.11)

This evidently implies that the *thirty-three* meant some sub-group excluding *aśvins* whose importance is obvious in the *RV*. Notwithstanding such differences, quite surprisingly, there is unanimity among all the authorities that the total number of VD is 3339.

This number is deliberately connected with *agni* which in turn has had a link with VD, and is repeated twice in the *RV* in the third and the tenth books.

The hymn *RV* (in the third *maṇḍala* (III. 9)) is by Gāthina Viśvāmitra, a legendary figure of immortal fame in the cultural history of India. This hymn has *agni* as its deity. The main purport of the hymn is to invoke *agni* who has to come from a distance, being hidden as the child of celestial waters. In brief, the legend alluded here is that, *agni* was hiding in a cave like a lion, till *viśvedevāḥ* searched him and found him out (*RV* III. 9.4). The next verse mentions that *mātariśvan* has brought by force this *agni* who was playing at a

distance.[20] Sāyaṇa interprets *mātariśvan* as atmospheric wind which can bring fire by force. The phrase *sasṛvāmsamiva* is explained as like bringing a son by force who was playing somewhere at will.[21] This simile is quite unusual, since it indicates something that was long awaited, to have happened suddenly. Beyond this the cosmic action of this *agni* is not made explicit in this hymn. The last verse of the hymn is about the above *agni* being worshipped by 3339 deities. This verse occurs again in the tenth book. The text with the translation by Aurobindo of this verse is[22]

> त्रीणि शता त्री सहस्राण्यग्निं त्रिंशच्च देवा नव चासपर्यन्।
> औक्षन् घृतैरस्तृणन् बर्हिरस्मा आदिद्धोतारं न्यसादयन्त॥ *RV* (III. 9.9; X. 52.6)
>
> Gods three thousand and three hundred and thirty and nine waited upon the Fire. They anointed him with many streams of the clarity; they spread for him the seat of sacrifice, and seated him within as Priest of the call.

This verse is the famous *nivid* that specifies the number of *viśvedevāḥ* to be 3339. Why this verse and the characteristic number find mention twice in the *RV* is not explained in the Vedic literature. However the use of this special number in the *RV* appears to be by design since the context of the hymns III. 9 and X. 51-55 are fairly similar.

3.4 *Saucīka* hymns

Hymn X. 52, where the number 3339 occurs for the second time in the *RV*, is about *viśvedevāḥ* attributed to the authorship of *Saucīka Agni.* It is possible this name of the composer is notional and not meant to denote any real person. If *viśvedevāḥ* can be rendered as all-gods, the name *saucikāgni* can be translated as *indicator-fire.* This again makes one wonder what could have been the connection between *viśvedevāḥ* and *agni.* Quite interestingly hymns X. 51 and X. 53 are also by *Saucīka Agni* and these also contain cryptic metaphorical references to *devāḥ* and *agni.*

Hymn X. 51 is in the form of a conversation between *devāḥ* and *agni.* In verse 2, *agni* wonders 'how many gods have clearly beheld my form'. There is also an allusion, like in the *RV* III. 9 considered previously, to *agni* hiding in secret places. The legend outlined in the hymn is briefly as follows. *Agni* had three elder brothers who were doing the work of carrying sacrificial offerings to gods. All the three died due to the harsh *vaṣaṭ* sounds uttered during the sacrifices. Hence the youngest fire known as *saucīka* fearing the same treatment will befall him, was hiding in (celestial) waters, till *viśvedevāḥ* found him and requested him to come out and help in carrying sacrificial offerings to

[20] ससृवांसमिव त्मनाग्निं इत्था तिरोहितम्। ऐनं नयन् मातरिश्वा परावतो देवेभ्यो मथितम् परि॥ *RV* (III. 9.5)

[21] ससृवांसमिव। यथा स्वाच्छन्द्येन ससृवांसं सरन्तं गच्छन्तं पुत्रं पिता बलादानयति। तद्वत्॥ (Sāyaṇa *Bhāṣya* on *RV* III. 9.5)

[22] Hymns to the Mystic Fire, by Sri Aurobindo, S. A. Ashram, Pondicherry, 1998

gods. *Saucīka* agrees to their request under the condition that he should have prominent role in the *yajña* and that he should get the *prayāja* and *anuyāja* offerings. BD explains this legend at great length to conclude with the total number of VD as the sum of three different numbers, namely 3000; 309 and 30.[23] This establishes that bringing *saucīkāgni* was the prime role of the VD deities adding up to 3339. The next hymn *RV* X. 52 starts with *agni* asking VD to instruct him as to how he should pass on the sacrificial offerings to them. In verse 2 *agni* mentions *aśvins* as the *adhvaryus* and *samidh* or the moon as the Brahman in the *yajña.* Quite cryptically this *samidh* is offered as oblation to *aśvins.* The Vedic tradition does not identify *aśvins* with any specific celestial object but is quite clear that *samidh* should be equated with Soma and the moon.[24] The next verse (v. 3) alludes to counting of days or nights, where the reference is to one who springs to life month by month and by each day (*aharahaṛ jāyate māsi māsi*). The conclusion that this should be a reference to the moon is unavoidable. *Agni* being honoured by 3339 gods is the theme of the last verse (v. 6) of this hymn.

Hymn X. 53 contains nine verses attributed to VD and two to *saucīkāgni.* In the first two verses v. 1, 2 VD lauds *agni* who is sitting as the leader of the sacrifice. Significantly verse 2 is the *mantra arādhi hotā* prescribed to be meditated upon at the start of the Vedic *darśapūrṇamāsa* (DP) rituals observed at new moon and full moon. In verse 3 it is declared;

> *Agni* has arrived with the life (time) given to him by the gods and has made our offerings to the gods auspicious. We have obtained (understood) the secret of the sacrifice.

Tradition attributes this statement to VD. However, as a matter of fact, the poet is here most probably eulogizing a lunar eclipse, since moon as per the previous verse was the sacrificial offering. Moon was also the Brahmaṇ, who in Vedic parlance is the presiding officer during a sacrifice. This word also can mean one who had grown big indicating a full moon. The life given to *agni* by the gods has to be a time period and is to be connected with the number 3339. This secret of *agni*, who was the tongue of gods for drinking Soma, was known to the composer.

The next verse (v. 4) is by *agni* declaring the best advice by which gods can overcome *asuras,* where this word is used obviously in a negative sense. This verse, like the second verse above, is prescribed for use in the DP rituals.[25] Linked with the moon and the full moon rites the word *asura* might be an oblique reference to an eclipse. The next verse is also said by *agni,* but the

[23] तवाग्ने यज्ञ इत्येतत् प्रत्यार्धि स्विष्टकृच्च सः। यस्य त्रीणि सहस्राणि नव त्रीणि शतानि च॥
त्रिंशच्चैव तु देवानां सर्वानेव वरान् ददुः। ततोऽग्निः सुमना प्रीतो विश्वेर्देवैः पुरस्कृतः॥ (BD 7.75,76)

[24] कः समित् समिद्धः चन्द्रमाः। चन्द्रमा ब्रह्मा भवतु।...स च समित् समिद्धः चन्द्रमाः वां युवयोर्होमार्थं...आहुतिर्भवत्वित्यर्थः॥ सोमात्मको हि चन्द्रमा हूयते॥ (*Sāyaṇa Bhāṣya*, *MPRV* Edition)

[25] तदद्य वाचः प्रथमं मसीयेति समाप्य। *Āśvalāyana Gṛhyasūtra* (1.2)

second-half of verse 5 is more appropriately by the human poet requesting earth and sky for protection from earthly and heavenly pollution (*aṃhasaḥ*). Tradition takes the word *aṃhasaḥ* as *pāpa,* which in turn is usually translated as sin, which does not fit into the context. However, if we recognize that the sky picture of the moon being offered in sacrifice by *agni,* as an eclipse, the word *aṃhasaḥ* refers quite appropriately to the cosmic pollution caused due to the covering of the sun or the moon during an eclipse; a religious belief widely prevalent in cultures influenced by the Hindu world view. In verse 6 *agni* is asked by VD to follow the sun protecting the luminous path, which is a poetic but plausible reference to the ecliptic. This statement makes it clear, that in this context *agni* is not the sun, but some other agent which had actually approached the moon. In verse 7 the deities eligible to take Soma are asked to arrive in a chariot that is eight cornered or is bound eight fold.

Hymn X. 54 is about Indra the supreme force of the *RV*. It was observed previously in the *RV* (v. 40.6) that the covering of the sun by *svarbhānu* was removed by Indra. Here in (X. 54.6) also Indra is said to establish the light in the celestials.

Hymn X. 55 in the first two verses refers to Indra addressed as Maghavan with secret celestial forms. In verse 3 he is said to envelop heaven and earth with the same type of light. He oversees in various roles the five deities (*pañcadevān*), the seven-times-seven (*saptasapta* or forty-nine) entities season by season, along with the thirty-four (*catustriṁśatā*). The above three numbers should naturally refer to three sets of countable objects in the sky. Sāyaṇa's gloss takes the five deities to be the five tribes that include humans, which meaning is unlikely as humans are not referred as *devāḥ* in the *RV*. In verse (v. 5) the reference is to *vidhu*, that is the moon, whom Sāyaṇa interprets as *Indra in the form of Time.* The gist of this verse can be rendered as[26]

> He is woken up from his slumber running his course with many around him…. He who died yesterday is living today.

The next verse (v. 6) is even more cryptic in mentioning the arrival of the ancient red bird which has had no nest to dwell in (*aruṇaḥ suparṇaḥ anīḍaḥ* |). Again Sāyaṇa takes this red bird to be Indra, equated by him previously with *vidhu*, normally interpreted as the moon. If the poetic language is disentangled, the context can be understood to be a celestial event in which full moon is seen and an apparition of red colour also appears. Mention of the arrival of a red coloured bird with no permanent nest to reside, is easily recognized as a transient event associated with the total eclipse of the moon. The summary of the archaeo-astronomical information contained in the above five hymns is:

> *in the night sky, moon's colour turned red due to the arrival of saucīkāgni brought in by viśvedevāḥ numbering* 3339.

[26] विधुं दद्राणं समने बहूनां युवानं सन्तं पलितो जगार।
देवस्य पश्य काव्यं महित्वाद्य ममार स ह्यः सं आन॥ *RV* (X. 55.5)

3.5 Marriage of Sūryā with Soma

Hymn X. 85 in the *RV* is one of the most beautiful poetry in the whole of Vedic literature. This is popularly known as the marriage hymn describing the bridal procession of Sūryā for her union with Soma the moon. The implied imagery of a lunar eclipse, hidden beneath the ancient enchanting poetry of the meeting of two celestial persons, is quite apparent from the beginning of the hymn. This hymn also presents a window to one of the esoteric cosmic thoughts that forms the basis of Hindu mysticism. There are forty-seven verses in this long hymn. We consider here only those connected with Soma which in the *adhidaiva* sense is the moon as per the orthodox tradition of Yāska.[27]

The gist of the astronomical information available is as follows[28]

> Earth is held by truth and the heaven is upheld by the sun. Ādityas depend on the cosmic order, while the moon is stationed in the sky. (1)
>
> Soma the moon is stationed near the *nakṣatras.* (2)
>
> He who crushes and drinks the juice thinks that the herb is Soma. But only the seers know the real nature of the regent deity of Soma (the moon). (3)
>
> Soma! You are protected by seven layers of covers. Humans cannot take part in drinking you. (4)
>
> [Soma!] Whereas the gods drink you, you become bright again. The wind protects the Soma, while the moon is the creator of the years. (5)

The above five verses introduce the moon as the object of the hymn. The next seven verses (v. 6-12) describe the travel of sun's daughter Sūryā in the sky towards her husband the moon, in abstract terms. Her friends were *Lauds* and *Hymns;* her dress was made of *Sāma* music; her chariot was the Mind and her cover was the Sky. Two bright objects (*śukrau*) were the bullocks drawing her cart. In other words she was really invisible, till the poet was able to see her dress in colour much later in verse (v. 35). In this picture the two *aśvins* appear as visible, hinting them to be twin stars witnessing the act. Verse 13 provides the locus of the celestial marriage through a metaphor.

> सूर्याया वहतुः प्रागात् सविता यं अवासृजत्। अघासु हन्यन्ते गावोऽर्जुन्योः पर्युह्यते॥ *RV* (X. 85.13)

Traditionally this is rendered to mean:

> The bullocks of the cart with the wedding gifts were whipped in the *Maghā* asterisms. Sūryā was carried to her husband's place in the Arjunī asterisms.

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[27] समानां संवत्सराणां मास आकृतिः। सोमो रूपविशेषैरोषधिश्चन्द्रमा वा॥ *Nirukta* (11.4-5)

[28] सत्येनोत्तभिता भूमिः सूर्येणोत्तभिता द्यौः। ऋतेनादित्यास्तिष्ठन्ति दिवि सोमो अधि श्रितः॥1॥
सोमेनादित्या बलिनः सोमेन पृथिवी मही। अथो नक्षत्राणामेषामुपस्थे सोम आहितः॥2॥
सोमं मन्यते पपिवान्यत्संपिंषन्त्योषधिम्। सोमं यं ब्रह्माणो विदुर्न तस्याश्नाति कश्चन॥3॥
आच्छद्विधानैर्गुपितो बार्हतैः सोम रक्षितः। ग्राव्णामिच्छृण्वन्तिष्ठसि न ते अश्नाति पार्थिवः॥4॥
यत्त्वा देव प्रपिबन्ति तत आ प्यायसे पुनः। वायुः सोमस्य रक्षिता समानां मास आकृतिः॥5॥ (*RV* X. 85.1–5)

This is the literal meaning given by Sāyaṇa also. But in view of the context of the night sky being pictured, the word *gāvaḥ* in the *adhidaiva* sense should mean rays or light, which is an accepted meaning of the word as per the *Nirukta.*[29] This leads to the direct meaning:

The light rays (of the moon) are hit in passing through the Maghā stars, while Sūryā is carried over by the moon in the Arjunī stars.

This in plain language means the shadow on the moon started near group of six stars called Maghā the brightest among them being the ecliptic star Regulus. The eclipsed the moon progressed in time towards Arjunī which refers to the two stars of the *Pūrvāphalgunī nakṣatra.* In summary the eclipse was in the constellation Leonis. The next verse (v. 14) mentions that when *aśvins* arrived asking for Sūryā, their request was supported by VD. We are not sure of the role of *aśvins* in the sky picture, other than inferring they should have been two closely spaced stars, but mention of VD probably indicates a connection with their characteristic number 3339. Verses 18 & 19 are about the playful nature of the sun and the moon, where the property of being reborn is associated with the moon. The hymn from verse 20 onwards digresses on to the marriage of humans except in a few places where Sūryā is referred. For example verse 35 is about the visible form of the three-fold dress of Sūryā the pollution due to which only a seer can relieve. Similarly, the upper cloth of a human bride is said to be afflicted by a deity, *dark coppery red in colour.* This reference to coppery red in relation to Sūryā can be inferred to be the colour of the moon's orb as seen from earth during a total eclipse. We have seen previously that *viśvedevāḥ* are the deities who bring *agni.* In verses 38-41 Sūryā is said to have been given to *agni* by the *gandharva* who in turn got her from Soma. The hymn presents a picture of the night sky, with the moon being visible. Circumstances describing the journey of sun's daughter, named Sūryā to marry the moon and the coppery red colour of the apparition indicate a total lunar eclipse. Mystically, this event highlights the cosmic *agni-soma* union.

3.6 Vedic long count 3339

From the above analysis a physical connection between the 3339 *viśvedevāḥ* and an *agni* who can cause eclipses is seen to exist. Even if the hymns were to be taken as mystical poetry the reference to the waxing and waning of the moon and further eclipse imagery is too conspicuous to be overlooked. Most probably in the early stages of theorization, *svarbhānu* and Sūryā, both literally indicating a connection with the sun, were taken to be the active external partners in solar and lunar eclipses caused by *agni* brought in by *viśvedevāḥ.* The intriguing aspect of this ancient theory of eclipses is the number 3339 and its intended meaning. The extant Vedic texts are essentially silent on

[29] स्वेदयः। किरणाः। गावः। रश्मयः। सुपर्णा इति पञ्चदश रश्मिनामानि॥ *Nirukta* (1.5)

this. Sāyaṇa's gloss on the *Taittirīya Brāhmaṇa* (II.7.12.2) where this number 3339 occurs, declares that over and above the thirty-three *RV* deities others are supernumeraries. Some modern day scholars have also speculated on the nature of this number. Shama Shastry takes 3339 to be the number of year-gods and looks for a link with a 33 year cycle.[30] Sarma interprets this as a period of thirty years consisting of 371 lunar months.[31] Kak thinks that 3339 is the total number of gods in a year personified as *agni.*[32] He breaks the number into its factors 9 and 371 to identify the first as the *bhāṃśās* in a *tithi* and the latter as the number of *tithis* in a solar year. While these authors have at least guessed this number to be associated with a time measure, majority of indologists and historians have presumed this to be just a part of variable Vedic mythology, wherein the number of gods increased from thirty-three to higher figures (even 33 Crores) with time. This type of speculative generalization has happened due to literalistic interpretation of Vedic texts following the sacrificial tradition ignoring the celestial nature of the deities and their actions. On the other hand, *Purāṇas* by tradition are supposed to be of help in understanding the *Vedas.* In fact the *adhidaiva* tradition is preserved in bits and pieces in some of the *Purāṇas.* Fortunately, the physical meaning of the above number 3339 and related legends are well preserved in the *Brahmāṇḍa Purāṇa.*

3.7 Purāṇic harmony

The eighteen major and eighteen minor *purāṇās* make up an enormous body of Sanskrit literature, not easy to read, much less to synthesize to see the common cultural threads linking them to the *Ṛgveda.* Here, the *Brahmāṇḍa Purāṇa* (BP) will be considered briefly to bring out the rationale behind the 3339 *viśvedevāḥ* of the *Ṛgveda.* All the important *purāṇas* describe the night sky and present ancient astronomical models based on *Meru* and the pole star. In a few of the available texts the nucleus of this sky model can be traced back to the *Vedas.* The BP, one of the earliest among the eighteen *purāṇas*, explains the waxing and waning of the moon as part of its astronomy. A few verses are given below with a working translation to appreciate the legend of *somapāna* (drinking of the moon), by the gods

आपूरयन् सुषुम्णेन भागं भागमहः क्रमात्।
सुषुम्णाप्यायमानस्य शुक्ला वर्धन्ति वै कलाः॥ BP (I.23.61)

The bright parts (of the moon) increase in the *śukla pakṣa,* with the sun filling them up in daily sequence through his *suṣumṇā* ray.

[30] *Drapsa the Vedic Cycle of Eclipses* by R. Shama Shastry, Mysore 1938.

[31] Sarma K. V. *A Survey of Source Materials;* IJHS, 20.1-4, 1985 pp.1-20.

[32] *Astronomical Code of the Ṛgveda* by S. Kak, Munshiram Manoharlal Publications, New Delhi 2000.

भक्षार्थममृतं सोमः पौर्णमास्यां उपासते। एकां रात्रीं सुरैः सर्वैः पितृभिः सर्षिभिः सह॥ सोमस्य कृष्णपक्षादौ भास्कराभिमुखस्य तु। प्रक्षीयन्ते पितृदेवैः पीयमाणाः कलाक्रमात्॥ त्रयश्च त्रिंशतश्चैव त्रयस्त्रिंशत् तथैव च। त्रयश्च त्रिसहस्राश्च देवाः सोमं पिबन्ति वै॥ इत्येतैः पीयमानस्य कृष्णा वर्धन्ति वै कलाः। क्षयन्ति तस्मात् शुक्लाश्च कृष्णाऽप्याययन्ति च॥ BP (I.23.66-69)

Moon is approached by all the deities, manes and Ṛṣis for a night on full moon, for partaking nectar. From the beginning of the dark fortnight, parts of the moon facing the sun, decrease being drunk by the manes digit by digit. Three hundred and three, then thirty-three and again three thousand and three gods drink Soma. Being drunk this way, the dark digits increase with corresponding decrease in the bright digits.

This is a clear enunciation of the scientific naturalism behind the 3339 gods and what their role must have been in the *Ṛgveda.* The nomenclature of the deities might have changed, but these were special and their count was sequential, in the order of the decreasing phases of the moon adding to 3339. The above description is in tune with the *Ṛgveda* and the Vedic ritualistic picture of the moon and drinking of Soma by the gods. The tripartite Vedic division of *viśvedevāḥ* is also maintained in the *purāṇa* as the sum of three numbers 33, 303 and 3003.

3.8 Eclipse cycle of 18 years

The symbolism of gods drinking the digits of the moon, which obviously refers to the dark fortnight, and their total number being 3339, has its origin in the *Ṛgveda.* For this characteristic number the above *purāṇic* model has to be accepted as the proper explanation. The count started on *pūrṇimā* to proceed till *amāvāsya* and stopped till the next full moon, to repeat again in the same fashion with gaps in the bright fortnights. In other words, this number is the count of *tithis* only in the dark fortnights summed up as 3339 sequentially for a special purpose. If both the fortnights were to be included, the real time elapsed by this count would be 6678 *tithis.* At the rate of thirty *tithis* per lunation, this long count is equal to 222.6 lunations, which in round figures is the eclipse cycle of 223 synodic months. It is known that for the Vedic people months were lunar but the year was solar. It is also known from Lagadha's *Vedāṅga Jyotiṣa* that one solar year was taken to have 371 *tithis.* Hence the Vedic number 3339, which is half of 6678, is a proxy for 18 solar years. *Agni, viśvedevāḥ, yajña* and *somapāna* described in various places of the *RV* are symbols or metaphors for technically modeling the celestial phenomenon of similar lunar eclipses. The context of the number in the *RV* and evidence from the BP leads to the conclusion that the number 3339 was the Vedic long count of nights or *tithi* linked with lunar eclipses occurring near the same *nakṣatra.*

3.9 Other Vedic texts

Later texts such as the *Taittirīya Saṃhitā* (*TS*), the *Śatapatha Brāhmaṇa* (ŚB) and the *Tāṇḍya Brāhmaṇa* know the solar eclipse of the *RV* but describe the

same in different ways. The *Taittirīya Saṃhitā* has a sacrificial interpretation mentioning that the eclipse shadow, as it receded, was taken to be a barren divine animal (*devapaśu*). It is said that the gods discussed as to whom that animal should be offered.[33] There is no mention of Atri or Indra in this hymn. ŚB (v. 3.2.2) also knows *svarbhānu* and the solar eclipse. This text attributes the release of the sun from darkness to Soma and Rudra. Soma is the moon and solar eclipses occur only on *amāvāsya* day when the moon enters the sun as per the *Aitareya Brāhmaṇa.* Rudra is the progenitor of the *marut* group, which had covered the sun's eye once in the past. This might be the reason for ŚB to link the release of the sun to Soma and Rudra. *Kauṣītaki Brāhmaṇa* (XXIV. 3-4) describes the eclipse quoting the *RV* (v. 40.9) and linking the event with the *svarasāman,* the *saptadaśastoma* and the *viṣuvant* day. *Tāṇḍya Brāhmaṇa* (IV. 5.2; IV. 6.13) refers to *svarbhānu* and a solar eclipse. Most probably this is also a reference to the solar eclipse of the *RV.* However, Sengupta has treated the two events as independent and also dated them under assumptions that are not independently verifiable.[34] According to him the *RV* solar eclipse is dateable to the summer solstice day corresponding to 26th July 3928 BCE. Since the *Tāṇḍya Brāhmaṇa* refers to the *svarasāman* days along with the solar eclipse he has argued that this eclipse should have happened on the equinoctial day corresponding to 14th September 2451 BCE. Stockwell based on the interpretation of some German scholars that the *RV* solar eclipse occurred three days before the autumnal equinox, dated the *RV* eclipse to 20th October 3784 BCE.[35] From several considerations it appears that all the Vedic texts refer only to the original total solar eclipse of the *RV* experienced in the 4th millennium BCE.

The *Vājasaneya Saṃhitā* (33.7), the *Kāṇva Saṃhitā* (32.7) of the *Śukla Yajurveda* and the *Khilasūkta* of the *RV* repeat the *viśvedeva-nivid* of *RV* (III. 9.9). The *Taittirīya Brāhmaṇa* (*TB*) records the same hymn at (II. 7.12.2). Thus, the use of the number 3339 was wide spread in ritualistic observances. *TB* (I. 3.10) describes the legend of Indra returning on an *amāvāsyā* after having defeated *asuras.* It further refers to the arrival of *pitṛs* at that time and they being given a boon to drink Soma on *amāvāsyā.* Their number is said to be six as being related to the six seasons. This most probably refers to a solar eclipse the details of which are not available now.

Ṛgvedic hymns describe or at least allude to eclipses in poetic fashion relating the events with *Agni, Soma, Viśvedevāḥ, Yajña, Indra, Svarbhānu, Sūryā* and the coppery red colour. But the significance of number 3339 that appears in association with VD is no where stated in the *Vedas.* The *purāṇa* text presents the meaning of the number clearly but stops short of relating it

[33] स्वर्भानुरासुरः सूर्यं तमसाऽविध्यत् तस्मै देवाः प्रायश्चित्तमैच्छन्.....ते देवा अब्रुवन् देवपशुर्वा अयं समभूत् कस्मा इयमालप्स्यामह इति॥ *TS* (II. 1.2.2)

[34] Ancient Indian Chronology by P. C. Sengupta, Univ. of Calcutta, 1947.

[35] Stockwell J. N., *The Astronomical Journal,* XV, 10, 1895 Boston.

to eclipses. However, by combining the Vedic and purāṇic information we can safely conclude that the Vedic people knew the so called *saros* of 223 lunations, nearly equal to eighteen years, in a more fundamental and hence original form as 6678 *tithi.* Discovery of this number and its use in describing a natural astronomical event represents the earliest development of scientific thinking in India. This knowledge probably was treated as secret and hence its origin has so far remained shrouded in mystery. Such a special number surely would have left its foot prints on the sands of time and hence gets revealed once the archaeo-astronomical metaphors are uncovered as demonstrated above.

3.10 Discussion

Evidence available so far, points out that the long count number was discovered with the help of lunar eclipses. This is implied by the counting of the 3339 *tithis* starting from a full moon and carrying this count only during the dark fortnights, to end on an *amāvāsyā.* The expectation would have been that the subsequent full moon would be an eclipse night. Duncan Steel in his famous monograph on eclipses discusses how ancient civilizations could have arrived at the 18-year cycle by observing the moon rather than marking solar eclipses.[36]

Vedas are broadly divided into *Saṁhitā, Brāhmaṇa, Āraṇyaka* and *Upaniṣad.* The *Ṛgveda Saṃhitā* is the most ancient with parts of the text belonging to as ancient as the 4th millennium BCE. *RV* as available now is organized as *sūkta,* made up of mantra or metrical verses endowed with knowledge said to have been revealed to a *Ṛṣi* (seer). What is interesting is that the text contains special numbers, at least one of which, namely, 3339 is a long count connected with the 18-year lunar eclipse cycle. *Brāhmaṇā* texts are taken to be explanatory guides for the *Saṃhitās.* However, in their available format, the explanations are too convoluted with ritualistic jargon and hence not easily amenable for establishing a one-to-one relation with the original hymns. In the present case the *Brahmāṇḍa Purāṇa* preserves a simple explanation for the above number. This leads us to the conclusion that 3339 represents the *tithis*, in the dark fortnights, separating two lunar eclipses with roughly the same celestial circumstances and features. *Tithi* is a time unit well known to *Vedāṅga-jyotiṣa, Purāṇas*, siddhāntic astronomy and continues to be used in India to this day. The present study indicates that this concept has come down to us from the times of *RV*, even though how it was originally measured is not yet completely understood. But it may be noted, the word *tithi* in the sense of date in a year is explicitly used in the *Śatapatha Brāhmaṇa.* Unfortunately those who read only the English translation of this important Vedic text miss

[36] *Eclipse- The celestial phenomenon that changed the course of history,* by D. Steel; National Academy of Sciences, USA, 2003.(http://books.nap.edu/catalog/10123.html)

this word since Eggeling in his translation left out this word.[37] Since there are some historians who hold on to the opinion that the word *tithi* is not of Vedic origin, it is necessary to quote the original text. This appears in the legend of Manu's Flood (ŚB I. 8.1)

स यत्तिथिं तत्समां परिदिदेश तत्तिथिं समां नावमुपकल्प्योपासां चक्रे॥

This alludes to the promise of the Fish to come on a specified *tithi* in a specified year and that Manu awaited the arrival of the Fish on that *tithi* in that year with a boat ready for travel. Although no specific year or day is mentioned the word *tithi* has been used in this early Vedic text in the sense of date.

Now, turning our attention to *Purāṇas*, there is a view that in the remote past these were fewer in number. Since the present day versions contain same or similar texts in too many places, it is logical to postulate the origin of these books from a single source, which is not traceable in its original form now. Existence of *itihāsa* and *purāṇa* are known at least from the Vedic *Brāhmaṇa* and *Upaniṣad* times as evidenced in *TB* (III. 12.8.2) and the *Chāndogya Upaniṣad* (3.4.1). It is possible, like the *Brāhmaṇas* explaining the ritualistic and the *Upaniṣad* the philosophical aspects (*Bṛhadāraṇyaka Upaniṣad* III. 9), that the *Purāṇa* once explained the physical worldly meaning of the *Vedas.*

The legend of gods and manes drinking nectar of the moon appears in several *Purāṇas.* Since, at present, the texts are inflated and have many errors due to transmission and copying problems, it is difficult to discuss the numbers mentioned differently in some of these texts. For example, in the vulgate *Viṣṇu Purāṇa* (VP) and the *Liṅga Purāṇa* (LP) texts we read,

त्रयस्त्रिंशत् सहस्राणि त्रयस्त्रिंशत् शतानि च।
त्रयस्त्रिंशत् तथा देवाः पिबन्ति क्षणदाकरम्॥ (VP. II. 12.7)
त्रयस्त्रिंशत्शताश्चैव त्रयस्त्रिंशत् तथैव च।
त्रयस्त्रिंशत्सहस्राणि देवाः सोमं पिबन्ति वै॥
एवं दिनक्रमात् पीते विबुधैस्तु निशाकरे।
पीत्वार्धमासं गच्छन्ति अमावास्यां सुरोत्तमाः॥ (LP. 56.11-12)

The numbers of deities mentioned above add to 36333; whereas the remaining statements are as in the *Brahmāṇḍa Purāṇa.* There is no reason to believe that VP and LP propose astronomical models different from the one that appears in BP. It is found that BP is more reliable for matter-of-fact astronomy than VP. Hence we can take the number 3339 as the valid Vedic long count restated

[37] The *Śatapatha Brāhmaṇa* (English Translation in 3 vols. SBE series) by J. Eggeling. Motilal Banarsidas, N. Delhi, 1963. Extracts from the translation of J. Eggeling: "…Thereupon it said, in such and such a year that flood will come…when the flood has risen thou shalt enter into the ship…. And in the same year which the fish had indicated to him, he attended to (the advice of the fish) by preparing a ship; and when the flood had risen, he entered into the ship…hence that (slope) of the northern mountain is called Manu's descent. The flood then swept away all these creatures, and Manu alone remained here." (ŚB I. 8.1)

in the *Purāṇas* also. How was this number observed, marked and counted? What could have been the influence of this number on the *darśapūrṇamāsa* sacrifice which draws inspiration from the *Saucīka* hymns of the 10th book of the *RV*? These questions are studied in the next section.

4 *Darśapūrṇamāsa* rite, moon's abode and calendar

In the previous section we have seen that the *RV* associates the occult number 3339 with the moon in the *Saucīka* hymns of the 10th book. The *mantras* of these hymns are prescribed for use in the *darśa-pūrṇamāsa* sacrifice (new moon-full moon rite or DP rite), thus hinting at a possible connection between the DP rites and the above number. As the name itself indicates, DP rite in the earliest period of its institution must have been based on directly observing the moon, till a practical calendar was developed. The *Vedāṅga Jyotiṣa* (VJ) of Lagadha spells out its objective as providing a way to know the correct times for observing Vedic rites. Hence, we can safely say that the algorithmic VJ calendar is later than the Vedic rituals such as the DP rite. A question of seminal importance is how the characteristic lunar number 3339 was traced and counted over a long period of time of at least 18 years, before the evolution of a formal calendar? What connections could exist among the long count, lunar eclipses, the DP rite and the VJ? In this section these questions are addressed, to the extent possible, by analysing some of the Vedic texts for available clues.

4.1 *Darśa-pūrṇamāsa-iṣṭi*

Ancient Vedic practices prescribe offerings in fire to be carried out on various occasions. Among these the *darśapūrṇamāsa-iṣṭi* (DP rite) is an astronomy related religious practice, as the name directly indicates. The ritual is also known as DP-*yāga* and sometimes as DP-*yajña.* According to *Āpastamba*, an ancient authority on Vedic rituals, DP rite is prescribed by both the *Ṛgveda* and the *Yajurveda.*[38] There are no explicit statements about the performance of this rite in the *RV* other than the *Saucīka* hymns which are prescribed for use in the DP rite by all the authorities. Hence, this can be taken as a clue provided by the tradition that the *Viśvedeva* number 3339 is connected with the DP rite and the moon. The ritual is described to varying levels of detail in the texts belonging to the *Yajurveda.* The construction of the altars in which sacrificial oblations are offered is described in the *Śulbasūtra* texts which are formulaic and preserve the scientific developments of the Vedic period in some detail. The mathematics and geometry behind the construction of the different shaped altars have been investigated in the past notably by

[38] यज्ञं व्याख्यास्यामः॥ ...ऋग्वेदयजुर्वेदाभ्यां दर्शपूर्णमासौ॥ *Āpastamba-paribhāṣā-sūtra* (1-4). (Ed.) A. M. Śāstri; Mysore, 1893.

Datta,[39] Sarasvati,[40] Sen and Bag,[41] and Seidenberg.[42] A variety of geometric shapes are prescribed in the texts. But the symbolism behind them is explicitly made known only in a few cases. While the square, circle and semicircle are relatively simple, the geometrical design of the *śyena-citi* (Falcon altar) is complex. However as the name indicates, the required shape of this altar is of a bird. We may conjecture that based on some type of physical observation, experience or principle, the shapes first came into vogue, the details of which are not available now. Another important prescription of the Vedic altars is in their specified area. The *gārhapatya, āhavanīya* and *dakṣiṇa* altars that are respectively circular, square and semicircular have to be equal in area. This principle demands squaring a circle and circling a square which eventually leads to estimating the irrational quantities π, $\sqrt{2}$, and $\sqrt{3}$ in terms of rational fractions.

The DP rite is among the *śrauta* sacrifices requiring a group of priests to assist the *yajamāna* (sacrificer) and his wife to complete the prescribed ritual. The details of the canonical hymns selected from different texts and the complete procedure of carrying out the ritual are available in print.[43] The DP rite needs four altars namely the *gārhapatya, āhavanīya, dakṣiṇa* and the *darśa-pūrṇamāsa-vedi* (DP altar). The last one is also known as *dārśikivedi* and sometimes as *antarvedi.* We have already seen that the first three of these are of different shapes but of equal area. These three altars are built with bricks in five layers to carry fire in them to make prescribed offerings. The most intriguing altar is the DP altar which is not built in five layers, has no fire lit on it and for all practical purposes is just a sacred platform, nonetheless indispensably central to the esoteric principles behind the ritual. The symbolism behind the DP altar is not described in any of the texts except for intriguing and cryptic hints. But the geometrical construction of this altar, which is like an enclosed platform, is carefully detailed so that the altar acquires a special curved shape. Since the DP rite is connected with the moon, it is natural to suspect that the DP altar should have some archaeo-astronomical significance linked with the moon.

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[39] Datta B. B., "The Science of Śulba, a study in early Hindu Geometry," Calcutta Univ., Kolkata, 1932

[40] Sarasvati T. A., "Geometry in Ancient and Medieval India," MLBD Publ., Delhi 1979.

[41] Sen S. N. and Bag A. K., "The Śulbasūtras with Text, Translation and Commentary," *it INSA,* N. Delhi, 1983.

[42] Siedenberg A., "The geometry of the Vedic rituals," in *Agni*, Frits Staal (ed.), Vol. 2, 95-12, 1983.

[43] Paranjape V. R., (Ed.) *Śrauta Sanjīvini-1; Darśapūrṇamāsa Prayogaḥ.* Bhāratī Prabodha Śodha Samsthā; Sonda, 2007.

4.2 Design of the DP altar

The design and marking of the DP altar is described in several *Śulbasūtra* texts.[44] The details are nearly same in all the texts with some minor differences. All texts mention that the altar should be constructed symmetrically about the base line (*pṛṣṭhyā*) in the East-West direction. Here an interesting question would be how the E-W line was drawn. The *Kātyāyana Śulba* text prescribes the use of a gnomon for following the shadow of the sun to mark the E-W direction. The *Mānava Śulba* text proposes observing two visible stars to mark the E-W line. The text followed by the translation of Sen and Bag is:

> अन्तरेण चित्रास्वाती श्रवणप्रतिश्रवणौ कृत्तिकाप्रतिकृत्तिके तिष्यपुनर्वसू च प्राग्देशोऽयं युगमात्रोदितयोः पाशञ्च॥ *Mānava Śulbasūtra* (1.3)
>
> By the middle of a pair (of *nakṣatras*) *Citrā* and *Svāti*, *Śravaṇa* and *Pratiśravaṇa, Kṛttikā* and *Pratikṛttikā, Tiṣya* and *Punarvasū,* having risen 86 *aṅgulas* (above the horizon), is (fixed) is the eastern (cardinal) point, and it is (brought into a line) with the ties (of the chord).

This indicates that the line was drawn early morning, aligning it with the centre of specified pair of stars, when these stars were above the horizon by a *yuga* which is mentioned in other places to be equal to 86 *aṅgula.* How this altitude which is really an angular distance was measured is a matter of conjecture. We guess that *aṅgula* as a known linear measure was used to fix the angular position of the stars above the horizon with the help of a vertical staff. Four star pairs are mentioned for this purpose most probably corresponding to the four quarters of the year. These are: *citrā-svātī; śravaṇa-pratiśravaṇa; kṛttikā-pratikṛttikā;* and *tiṣyā-punarvasū.* The method suggested seems to be to identify a pair of visible stars early in the morning in the eastern sky and mark a line on the ground as if the line passes in between the two stars. The statement that *kṛttikā* (Alcyone) once arose precisely due east as per the *Śatapatha Brāhmaṇa* gives credibility to the E-W alignment of the central axis of the DP altar for some esoteric astronomical purpose. The stars *citrā* and *svāti* (Spica-Arcturus) are on either side of the celestial equator. The two appear nearer to each other and hence these two when visible a few degrees above the eastern horizon can indicate the eastern direction. The details of fixing the staffs to make the E-W marking are not available in the texts. But from the *Taittirīya Brāhmaṇa* (I. 5.2) it is known that Vedic people observed a desired *nakṣatra* before the sunrise and made marks on ground to estimate the time remaining for the star to be visible in the eastern sky.[45]

Once the E-W line is taken as drawn, further construction is symmetric about this line. First an isosceles trapezium $ABCD$ is drawn as shown in Figure 1. The eastern and the western sides AC and BD are respectively 48 and 64

[44] Sen S. N., and Bag A. K., *ibid.*

[45] यत्पुण्यं नक्षत्रम्। तद्भट् कुर्वीतोपव्युषम्॥ यदा वै सूर्य उदेति। अथ नक्षत्रं नैति। यावति तत्र सूर्यो गच्छेत्। यत्र जघन्यं पश्येत्। तावति कुर्वीत तत्कारी स्यात्। पुण्याह एव कुरुते॥ *TB* (I. 5.2)

aṅgula in length. The height of the trapezium is 96 *aṅgula.* With points C and D fixed, a rope of length $2CD$ is stretched in the southern direction till point F. With F as the centre and FC as the radius, an arc of a circle is made to pass through points C and D. This is repeated symmetrically on the northern side AB. Similar arcs are drawn on the eastern and western sides. This altar is not a *citi* wherein offerings are made in the fire; hence there are no prescriptions about the shapes of the bricks to be used on this altar. Nevertheless this altar is as important as the other three altars in the DP rite. Principally *darbha* grass is spread on the DP altar for seating special deities and water ablutions are offered on this altar to *Ekata, Dvita* and *Trita* the three elder brothers of *Saucīkāgni* of the hymns of the *RV* X. 51-55.

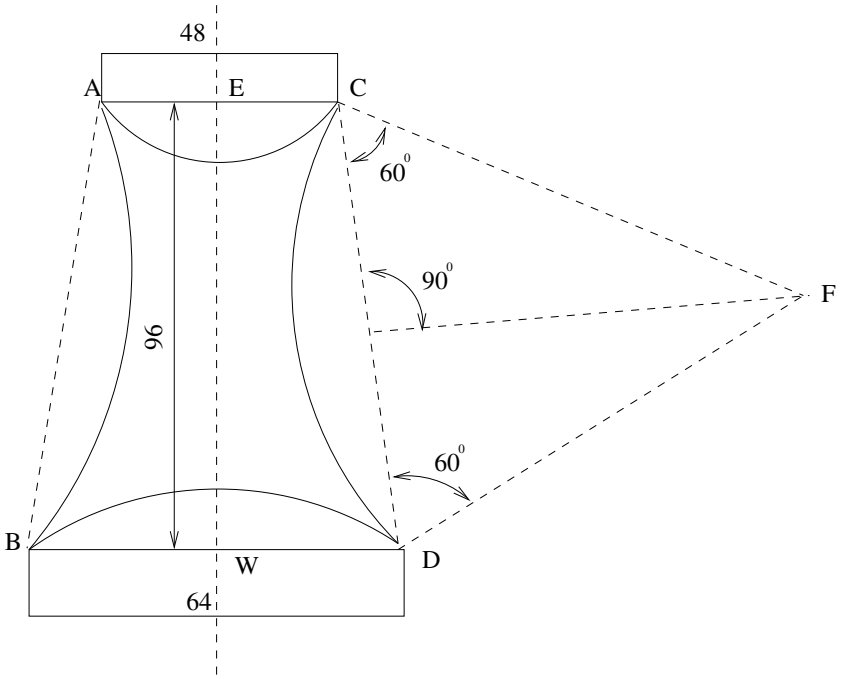

Fig. 1: Geometry of the *Darśapūrṇamāsa* altar.

4.3 Area of the DP altar

An important concept associated with a Vedic altar is its shape and area. As per the *Śatapatha Brāhmaṇa* the circular *gārhapatya* is supposed to represent the earth, whereas the square *āhavanīya* stands for the sky. Both these altars along with the semicircular southern altar are of same area equal to one *vyāma.* The DP altar is situated within the space enclosed by the above three as shown

in Figure 2. The positioning of the DP altar between the circular earth and the square sky naturally implies that its special shape hides a cosmic symbolism. The ritual manuals discriminate the DP altar from the other three altars for some special reason. What strikes the eye is the peculiar shape of the altar which is deliberate and painstakingly explained in the manuals. The principle of equivalence of the areas encourages us to find the area of the DP altar, the construction of which is available in the *Baudhāyana Śulbasūtra* among others. The area of the basic trapezium (Figure 1) is 5376 square units. Since by construction CDF is an equilateral triangle, the area of the curved region cut out from the trapezium is $\left(\frac{\pi}{6} - \frac{\sqrt{3}}{4}\right) CD^2$. The exact length of the side CD is $96\frac{1}{3}$ units, which is slightly more than the height of the trapezium.

Fig. 2: A photograph of the altar used for the *Darśapūrṇamāsa* rite.

From these considerations the area cut out on the four sides of the trapezium can be found to be 2261 units. This gives the exact area of the DP altar to be 3115 units. It is to be noted here the above value is based on the presently known accurate values of the irrational numbers π and $\sqrt{3}$ and the exact expression for the area of the arc of a circle. Here we may pause and ask: what could have been the area the ancients desired to have for the finished altar? Since no text mentions this area but only gives the construction, we attempt to estimate the desired area to the level of approximation of the *Śulbasūtras.*

If the *Saṃhitā* and *Brāhmaṇa* texts represent earliest observations of the sky, the *Śulbasūtras* are records of early Indian mathematics and geometry. The area of a circle was estimated by dividing the figure into large number of

squares. In the present case for the arc of the circle in Fig. 1, our ancients must have used a similar approximation which is not available in the texts. However we can take errors in such approximations to be represented effectively by errors in the values used for the irrational numbers π and $\sqrt{3}$. The *Śulbasūtra* texts provide considerable information on how the above irrational numbers were handled by the Vedic people eventually arriving at approximate values. The best of the ancient approximations were $\pi = 3.0885$ (as a fraction) and $\sqrt{3} = \frac{26}{15}$ as explained in detail by Sen and Bag.[46] Hence the area implied to be removed from the basic trapezium was most probably equal to 2032 square units making the desired area of the final altar to be 3345 units. If the Vedic priests took the length of $AB = CD$ as 96 instead of the correct $96\frac{1}{3}$, the area of the DP altar would have been 3334 units. The above two numbers can be taken as fair estimates of the area desired for the altar when it was conceived for the first time in the remote past. This result is remarkable as the two values happen to be too close to 3339 the Ṛgvedic count of the deities *viśvedevāḥ* correlated with lunar eclipses as demonstrated in previous sections. Hence, we can infer beyond reasonable doubt that the desired area of the original DP altar was equal to 3339 units. This choice was not due to chance but was a deliberate selection to provide equivalence for the number of *viśvedevāḥ* to be seated on the DP altar in the Vedic rite. In turn, this number should have been the count of *tithi* in the dark fortnights between two similar lunar eclipses occurring near the same *nakṣatra.*

The above analysis helps us to unearth the symbolism behind the shape of the DP altar and the possible method adopted for counting the Ṛgvedic large number 3339. The Vedic and the *Purāṇa* texts mention that gods consume the moon digit by digit in the dark fortnights. In matter of fact language this means the waning the moon was observed each night and a count was kept. This is astronomically meaningful since in the dark fortnight the moon would be visible all through the night after its rise. Starting from a full moon rising at the sun set, the moon rise is delayed by about an hour on each subsequent night but remains visible till the sun rise. It is in this context the Vedic concept of deities drinking moon only in the dark fortnight has to be appreciated as a naturalism which is at the root of Vedic philosophy and religion. From modern astronomy it is known that moon's orbit is inclined to the ecliptic by about $\pm 5°$. Since the ecliptic and the equator are inclined at about 24° with each other an observer on earth will see the moon wandering, sinuously on either side of the local E-W direction. If at a fixed time, every night the observer were to follow the location of the moon, starting from its maximum deviation the figure over a long period of time will appear symmetric about the E-W line and curved on the N-S sides like the DP-altar. Actually this will be a bounded region in the visible sky apparently flat and aptly denoted as the *candra-maṇḍala* (moon's Abode) in the *Purāṇas.* The extreme southern and

[46] Sen S. N., and Bag A. K., *ibid.*

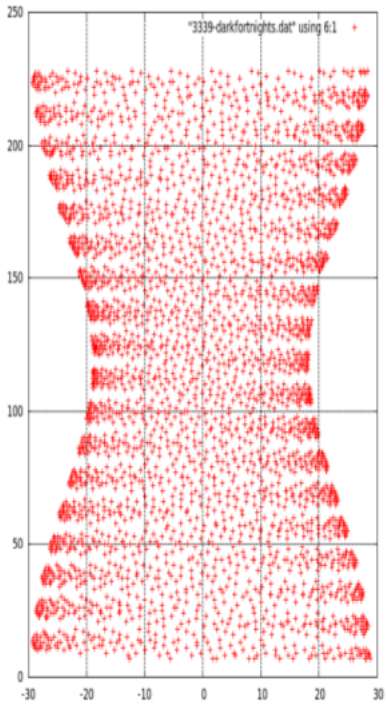

Fig. 3: Position of the moon for 3339 consecutive nights of the dark fortnights starting from 7th September 2006.

northern positions of the moon are similar to the solstices of the sun. *Vedāṅga Jyotiṣa* in fact mentions *ayana* ($N - S - N$ movement) for both the sun and the moon. But we have not come across unambiguous lunar standstill statements in the ancient texts. Nevertheless, the possible recognition of a standstill provides a clue to how the Vedic people might have kept track of the waning the moon. Suppose the Vedic astronomer (*nakṣatradarśa*) started with a lunar eclipse near a major standstill and marked the moon's declination approximately by placing a pebble or piece of stone on the ground, about a nearly $E-W$ line for 3339 nights, the resulting figure would be very similar to the DP altar. The counting method automatically correlates with the phase of the moon and eventually leads to the formal DP altar for purposes of calendar and religion based on cosmic concepts. A modern verification of this claim is demonstrated in Fig. 3. This figure is a plot of the declination of the moon for 3339 nights, starting at the bottom from 7th September 2006 with a lunar eclipse to end on the new moon of 24th September 2024. It can be verified an eclipse will take place on the subsequent full moon. The resultant shape of the diagram that transfers the position of the moon on to the ground will

be very robust as can be expected from Fig. 3. Even with many misses and mistakes the symbolic shape of the moon's abode in the sky gets captured fairly well by the DP altar. The enveloping boundaries are not circular, but the *Śulbasūtra* prescriptions are good approximations. This figure also helps us to understand how in ancient times the moon might have been observed for keeping count of *tithi.* Even though *tithi* is widely prevalent in India even now, the present way of fixing the *tithi* was not the method followed in Vedic times. In the previous chapter we have seen that the word *tithi* was used in Vedic times to denote a date within a year. We do not know precisely how this was done, but it certainly depended on the phases of the moon. The DP rite as described in the *Sūtra* texts and the still later manuals is strictly codified with precise instructions and minute details of Vedic hermeneutics. However, for the ritual to get fixed so accurately, considerable time should have elapsed during which period variable interpretations and observations must have been prevalent. We get some inkling about this in the texts which allows us to arrive at a plausible conjecture that the DP rite should have helped in the evolution of the Vedic calendar or *Vedāṅga Jyotiṣa* (VJ) of Lagadha.

DP rites are enjoined to be carried out for 15 years or 30 years or lifelong. The *Śatapatha Brāhamaṇa* (XI. 1.2.10) instructs

> One ought to perform DP-*yāga* for 15 years. In these there are 360 full moons and new moons. There are 360 nights in a year. He gains these nights (in 15 years). If he performs the DP-*yāga* for another 15 years, he gains the year itself.

The rationale here is that the lunar year has 360 *tithi,* where as the solar is 372 *tithi* long. This difference of 12 *tithi* can be made up in 30 years since, $12 \times 30 = 360$ to bring the two rhythms together. This, of course, does not make the solar and lunar years to correctly synchronize, due to the contrasting length of the solar year. But it is only through such efforts that the VJ with better intercalation could have evolved.

4.4 VJ calendar and the Vedic long count

VJ is a text critically edited and studied in the past by several scholars.[47] Hence, here we limit our attention to the investigation of how the Vedic long count could have influenced VJ. It is known that the Vedic people had a luni-solar calendar where the year was solar but the months were lunar. Intercalation was practiced to bring the solar and lunar year into harmony by various methods. The central theme of VJ is to provide an algorithm to find in advance the *tithi, parvan, nakṣatra* in the formalized Vedic five year cyclic calendar. Thus its focus is not observational but essentially computational.

[47] Sastry T. S. K (Ed.) *Vedāṅga jyotiṣa of Lagadha*, IJHS, 19.4. Supplement, pp l-74. INSA N. Delhi, 1984, Shamasastry, R. *Vedāṅga Jyotiṣa, Text, Translation and Commentary*, Mysore. 1936., Kouṇḍinyāyana S. A., *Lagadhamuniproktam Vedāṅgajyotiṣam* (with commentaries of Somākara and Kauṇḍinyāyan) Chaukamba Vidyabhavan. Varanasi, 2005.

VJ has come down to us in two branches, namely the *ārca-jyotiṣa* and the *yājuṣa-jyotiṣa.* The basic elements are common to both and hence the two are generally considered together as a single tradition of ancient Vedic astronomy. The basis of VJ is the five year *yuga* period equated to 62 synodic lunar months of 1830 days, taken as equal to 67 sidereal months. There are 1768 moon rises and 1835 risings of the ecliptic star *Śraviṣṭhā (Dhaniṣṭhā, Vāsava*, β-Delphini), with which the sun and the moon came together at winter solstice ca. 1400 BCE. The length of a solar year according to VJ is 371 *tithi* or 366 days. Any three independent elements among the above parameters lead to the complete luni-solar calendar of VJ. There are several publications discussing the strength and weakness of VJ as a calendar. The glaring inaccuracy is with the length of the solar year which is too long. Hence if the formulae are used blindly, the results would perceptibly miss reality within a few years. However it has been pointed out in the past,[48] corrections were done in the form of intercalary months and dropping of *tithi* to keep the calendar in tune with the sun. There have been efforts to interpret VJ, claiming that the 19-year Metonic cycle is implied by the Ṛgvedic VJ text which would have lead to a near perfect synchronization between the lunar and solar movements.[49] This does not explain why Lagadha went in for a five year cycle with excess length of the solar year. Thus, the Metonic 19–year knowledge or equivalent long count could not have been the basis of VJ. It may be noted here that the five year cyclic calendar with 366 days per year was adopted also by the astronomical text *Sūryaprajñapti–Candraprajñapti,* (ca. 500 BCE) belonging to the Jaina tradition.[50]

4.5 The Vedic year

Vedic people had recognized several types of years such as the *nākṣatra,* the lunar, the *sāvana,* the solar and the intercalary year. The *Nidānasūtra* (v. 11-12) belonging to the school of the *Sāmaveda* states this as,

> षड्त्रिंशोनो नवोनश्च षडहोनोऽथ सावनोऽष्टादशभिः ज्यायान् अहोभिः सावनात् परो नाक्षत्रम् इति॥ मासश्च तस्य चैव त्रयोदश चान्द्रमसः सावनश्च उभावथाष्टादश्युतोनो अष्टासप्तत्रिंशते पौर्णमास्यां प्रसाधयेत्॥
>
> The year that is less (than the *sāvana* year) by 36, the year that is less by 9, that which is less by 6, then the *sāvana* year, then the year greater by 18 days. The sidereal year (less by 9) has thirteen months (of 27 each). The two kinds of years are the lunar and the *sāvana.* The year greater than 18 days has to be observed in (between) 37-38 full moon. (Shamasastry)

This was understood by taking a *sāvana* year of 360 *tithi* as the reference. The first one deficient by 36 was the *nākṣatra* year of twelve sidereal months making

[48] Abhyankar, K. D., Pre-siddhāntic *Indian Astronomy*, *ISERVE*, Hyderabad. 2002

[49] Holay, P. V., *Vedic Astronomy*, Apte Smarak Samiti. Nagpur. 1989.

[50] Kanhaiyalal (Ed.) *Sūryaprajñapti-Candraprajñapti, Jināgama Granthamālā*, 29 Beawar. 1989.

324 *tithi.* Then the one less by 9 was a lunar year consisting of 13 months of 27 *tithi* each. The *sāvana* lunar year of 360 *tithi* was made up of 12 synodic months. The solar year of 366 days and intercalary years of longer duration were also recognized. For our purpose the points to note are that the month was always reckoned with the help of the moon's position and the VJ solar year with 371 *tithi* was an approximate effort at making the *sāvana* year match with the position of the sun. The rich variety of years clearly indicates an effort at synchronization of two or three different observable celestial rhythms. Since it is the moon that was observed, the ancients must have first noted the synchronization between the sidereal and the synodic months. It is the near equivalence of 12 synodic months with 13 sidereal months, counted in terms of the sunrises, would have lead to the concept of year as a longer measure of time than the month. This harmonizes with the earliest Ṛgvedic word denoting year as *samā,* used in the sense of being same, coincident, equivalent. With the recognition of seasons as dependent on the sun, synchronization of three rhythms seems to have become important. The *Nidānasūtra* refers to this equivalence more accurately in the form of a verse which was already known to the Vedic community it was addressing,

> यस्मिन् वै परिवत्सरे सौर्यो मासोऽथ चान्द्रमसः। नाक्षत्रो न विलुप्यते कस्वित्तं वेद कस्वित्॥
> अष्टासप्तत्रिंशते तस्मिन् संवत्सरे मिते। सौर्यो मासोऽथ चान्द्रमसो नाक्षत्रो न विलुप्यते॥
>
> Who knows that year in which the solar, the lunar, and the sidereal months are not lost, who knows that? In the year measured by 37 or 38 (full-moons), the solar, lunar and the sidereal months are not lost. (Shamasastry)

This points to the approximation of 37 synodic months with 40 sidereal months, even though the latter number is not mentioned. Similarly, for the solar cycle also to have matched, 37 synodic months should have been taken equal to three (solar) years. The number word *aṣṭā-sapta-triṁśate* gives the meaning of being "*between 37 and 38*," not of 37 or 38, as in the above translation of Shamasastry.[51] Taking 30 *tithi* per month, one gets 1110 *tithi* in three (solar) years giving 370 *tithi* per year, which is nearly the value used in VJ. The above also hints at the presence of a three year cycle that should have existed before the improved five year cycle of VJ came into vogue. The text of the *Nidānasūtra* cited above is openly available on the internet.[52] However, it is to be noted that on page 72 of this web edition the words *atha sāvanaḥ* appear wrongly as *atha sādhanam,* which is not meaningful in the context.

In the available core Vedic literature there are no direct references to occurrence of eclipses during a ritual. But, a close reading of the hymns prescribed for the rites, shows several interesting statements pointing to a relation between eclipses and the ritualistic numbers. For example, the *Nidānasūtra* mentions a special sidereal year that falls short by nine (*navona*) in relation to

[51] Shamasastry R., *Drapsa: The Vedic Cycle of Eclipses,* Panchacharya Electric Press, Mysore, 1938.

[52] http://is1.mum.edu/vedicreserve/kalpa/shrauta/nidana_shrauta_sutra.pdf.

the *sāvana* year of 360 *tithi.* This year had 13 months of 27 *tithi* making the length of the year to be 351 *tithi.* This corresponds to a year of 346-347 (solar) days. What was being achieved by this, unless this had some hidden connection with the eclipse year? In modern parlance, eclipse year is the time taken for the lunar nodes to be in line with the sun and the moon, when an eclipse is possible. The well known eclipse period of 223 lunation is equal to 18.03 solar years or 6585.32 days. This consists of 19 eclipse years of 346.6 days. The unknown element here is the ancient way of measuring *tithi.* We can however be reasonably certain that it was associated with the phases of the moon. Nevertheless *tithi* was known to be less than the mean solar day with its value stated to be equal to 61/62 in VJ. Desire to avoid fractions in the remote period of Vedic astronomy must have given place to approximations in terms of integers with an error of one unit. Thus, the eclipse year length might have been approximated to 351 *tithi,* while its actual length was nearer to $351\frac{1}{2}$ *tithi.* Nineteen such years lead to $6669 - 6678\frac{1}{2}$ *tithi* which is twice the special number 3339 already stated in the *Ṛgveda* twice.

4.6 VJ parameters

With the above long count of 3339 *tithi*, we can understand how the basic VJ parameters might have been arrived at. The eclipse period must have been taken to be equal to 18 nominal solar years. This was a consequence of the older concept of 37–38 synodic months being equal to three solar years, consisting of 1110 *tithi* discussed above. If the solar year were to be taken equal to 370 *tithi,* one would directly get 18.04 years as the eclipse period. On the other hand to get a round figure; 18–year was taken as a special, perhaps occult number leading to 371 *tithi* per year, which is an important VJ parameter. Since we know that the correct solar day count would be 6585.32, dividing this by 18 gives the length of the nominal solar year to be 365.851 days rounded off to 366 by VJ. If one takes 223 synodic months as equal to 18 years, the first four convergent of the fraction $\frac{223}{18}$ are $\frac{12}{1}, \frac{25}{2}, \frac{37}{3}, \frac{62}{5}$. The last one, namely $\frac{62}{5}$ is the VJ approximation. This was an improvement over a previous approximation of $\frac{37}{3}$ which was known to the Vedic people as stated above in the *Nidānasūtra.* Similarly, since 223 synodic months are equal to 241 sidereal months, we can approximate the fraction $\frac{241}{223}$ as $\frac{13}{12}, \frac{27}{25}, \frac{40}{37}, \frac{67}{62}$. VJ uses the last approximation of 67 sidereal months as equal to 62 synodic months, which is better than the previous one of $\frac{40}{37}$ corresponding to three years, as mentioned in the *Nidānasūtra.*

4.7 Yajurvedic texts

There are several instances of numbers adding to 17, 18 or 19 as special length of years embedded in the *Yajurveda* texts. In the *Vājasaneya Saṁhitā* (XVIII. 24-28) the number sequences 1 to 33 of odd integers and 4 to 48

of even integers increasing in steps of four, are given followed by a list of symbolic animals with their ages. The ages mentioned are $1\frac{1}{2}, 2, 2\frac{1}{2}, 3, 4$ and 6 adding to 19 years. This is followed by offerings to seasons and months showing the context to be part of time worship. The same *Saṃhitā* at XXI 12-17 repeats year numbers adding to 19 associating them, respectively with meters *gāyatrī, uṣṇik, anuṣṭup, bṛhatī, paṅkti,* and *triṣṭup.* Similar statements occur in the *Kāṇva Saṃhitā* (30.24-28), and in the *Taittirīya Saṃhitā* (*TS* IV. 7.10), where the animal–ages add to either $17\frac{1}{2}$ or 18 years. The difference is due to the interpretation of the word *paṣṭavāham*, taken to be $4\frac{1}{2}$ or 5 or 6. The number of syllables in each of the above named meters increases by four and the total adds to 204 corresponding to the other total namely 17 years of 12 months each. Even in the ritualistic context the hymn appears to embed some type of number equivalence between the animal-ages and the meters. If the length of the year is taken as 360 *tithi*, we have $17 \times 360 = 204 \times 30$. On the other hand if it is taken as 354 days, we get the length of the synodic month to be $\frac{(17\times354)}{204} = 29\frac{1}{2}$ days, which is exactly the value adopted by VJ. As already noted the *nākṣatra* year of 324 nights/days with 27 units per month was also in vogue in ancient times. It is observed that $17 \times 324 = 204 \times 27$. Such interesting properties of the number 17 based on observation of the moon could have lead to the early adoption of this as Prajāpati's number in the *Vedas.* The immediate next hymn of the *Taittirīya Saṁhitā* (IV. 7.11-12) supports this inference. This is the famous sequence of seventeen odd integers 1 to 33, increasing in steps of 2, adding to 289 and equal to square of 17. This is followed by a sequence of even integers 4 to 48 increasing in steps of 4 adding to 312. The implied time-wise equivalence of two numbers in the previous hymn makes us wonder whether the number pair (289, 312) also has some useful astronomical property. Quite interestingly 289 synodic months are nearly equal to 312 sidereal months.

Even though there is a case for the VJ parameters to have come out of the observed 18 years, lunar eclipses are not mentioned in VJ. This situation may appear anomalous. However, there is mention of moon's lateral movement across the ecliptic, denoted as *ayana* similar to the seasons associated with the north-south movement of the sun. This has been ignored in the past as being of no astronomical significance. But as demonstrated in the previous section the Vedic DP altar is correlated with the lateral wandering of the moon in the sky. VJ mentions that there are 134 *ayana* or north-south-north movements of the moon in 67 *nakṣatra* months. Each *ayana* consists of three *ṛtu.* Even though this has nothing to do with the felt (weather) seasons associated with the sun, the lateral lunar movement is real to an observer on earth. The Vedic word *ṛtu* is usually translated as season as though indicating the felt weather. But in the earliest periods of scientific development, Vedic people had already noted that the "felt seasons" can be five or six or even seven in a year. This got formalized more accurately based on observation of the sun's position with the *nakṣatra* as in the *Maitrāyaṇīya Āraṇyaka* and later in the VJ, *Parāśaratantra*

and the *Vṛddhagarga Saṃhitā*, the details of which require a separate chapter. Here it suffices to point out that a *ṛtu* was defined as the time interval for the sun or the moon to cover a span of four-and-half *nakṣatra* space in the sky.

The moon stationed with a known *nakṣatra* say *Maghā* (Regulus) will come back to the same star after nearly 28 *tithi,* but not with the same phase. Thus starting with *māgha-pūrṇimā*, a sidereal month later, the *nakṣatra* will be *Maghā* but the *tithi* will not be *pūrṇimā.* During the course of this month, every night the moon can be observed to occupy different *nakṣatra* position in a sinuous fashion. This happens all through the (solar) year with nearly 27 *ayana* for the moon. VJ recognizes the similarity between the sun and the moon in the sense of what happens to sun in one year happens to the moon in one month. Further as the year evolves, the moon continuously wanders on either side of the 27 *nakṣatra* band closely representing the ecliptic. During this serpentine movement whenever a full moon occurs on the ecliptic, a lunar eclipse is possible. We have already seen how the symbolism of the 3339 *viśvedevāḥ* is connected with lunar eclipses. Number symbolism of meters, measures, areas appear in Vedic texts almost everywhere. The *Taittirīya Saṃhitā* starts with the DP rite hymns, elaborated in 14 *anuvākas* (sections). The number of syllables in these hymns adds to between 3339 and 3349. The 9th *anuvāka* is about the preparation of the *vedi* or the DP altar with interesting etiology. The legend of an *asura* named *Araru* and his shadow falling on earth is cited. The altar is enjoined to be dug for only four *aṅgula*, because a deeper altar belonged to the ancestors. This appears in the *Taittirīya Brāhmaṇa* (III. 2.9)

> (If the *vedi* should be) excessively (i.e. too deeply) excavated, it would belong to the Fathers (i.e. the deceased ancestors) (and it would not be fit for the sacrifice to the gods). He (the *Adhvaryu*) excavates it to such an extent that it is equal to Prajāpati, the mouth of the sacrifice. (Formerly) the *vedī* hid itself from the gods. They found it four *aṅgulas* deep (in the earth). That is the reason why it should be excavated four *aṅgulas* deep.[53]

One wonders whether there is a hint here that such altars were in use for a long time before the DP ritual got fixed. Even more interesting is the further laudation of the altar:

> पुरा क्रूरस्य विसृपो विरप्शिन्नुदादाय पृथिवीं जीरदानुर्या ऐरयन् चन्द्रमसि स्वधाभिः तां धीरासो अनुदृश्य यजन्ते॥ *TS* (I.1.9)
>
> ...you are the self-law....you the glorious one, take the earth.... by means of its self-law and place it on the moon.

[53] Dumont P. E., *The full-moon and new-moon Sacrifices in the Taittirīya Brāhamaṇa* (I Part, Text with Translation) Proc. Am. Phil. Soc., 101, 2, 1957, pp. 216-243.

This is the extract of the translation of the hymn by Kashyap.[54] As per *Sāyaṇa's* interpretation also the altar was used by the ancestors of the current practitioners to establish earth on the moon as per natural self-law (*svadhā*).

> पूर्वे यजमाना वेदिरूपं यां पृथिवीं कृत्स्नभूमेरासुर्याः सकाशादूर्ध्वमादाय चन्द्रमस्यमृतकिरणैः सार्धं स्थापितवन्तः इदानीन्तनास्तु धीमन्तः तामिमां वेदिं मनसानुचिन्त्य तस्यां यजन्ते॥
>
> *Sāyaṇa Bhāṣya* (*TS* I. 1.9)

Even though we cannot claim that the shadow of the earth falling on the moon was known to be the natural reason for the eclipse, the legends related to the DP altar, its shape and area perhaps directly point towards the pervasive influence of the Ṛgvedic number 3339 and its hidden meaning connected with eclipses, in the proceedings of the DP rite.

It is not surprising that eclipses, and their periodicity and predictability, have engaged the Hindu mind since the remotest past as evidenced by the *RV* and other Vedic texts. While legends, folklores and beliefs were plenty, observation, explanations and physical models were not lagging behind. The various *Purāṇas* allude to the mythical eclipse demon *Rāhu* but unequivocally equate this with the shadow of the earth, as in the *Brahmāṇḍa Purāṇa.*

> तुल्यस्तयोस्तु स्वर्भानुः भूत्वाधस्तात् प्रवर्तते। उद्धृत्य पृथ्वीच्छायां निर्मितो मण्डलाकृतिः॥
>
> *Brahmāṇḍa Purāṇa* (I Pt. 23.101)

The *Mahābhārata,* lauded as the Fifth-*Veda,* occupies the position of a text in transition between the *Vedas* and the *Purāṇas.* Although in the first book legendary explanations about eclipses are stated, in the sixth book a physical model in which *Rāhu*, the dark planet, moving below the sun and the moon but larger in size than the two celestial objects, is cited as the cause of eclipses.[55] Between such speculative efforts and the well reasoned mathematical astronomy starting with the common era, there was growth of matter-of-fact observational astronomy parts of which are still preserved in the *Parāśaratantra* and the *Vṛddhagārgīya Jyotiṣa.*

The DP rite is special in several ways. From the astronomical point of view, the DP altar holds an esoteric central role. The hymns used in the liturgy refer to the sky and there is always more than what meets the eye in Vedic rituals. In one place, the altar is said to be in the sky and protected in the north by Mitra and Varuṇa, with the invariable law.[56] Naturally this makes one wonder whether Mitra and Varuṇa, two of the most important Vedic deities could have been visible stars in the northern sky, with some special properties. Such cryptic statements add an extra dimension to the astronomy of the Vedic

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[54] Kashyap R. L., *Taittirīya Saṃhitā* (Text with Translation), Vol., 1 SAKSIVC, Bangalore. 2002.

[55] Bhīṣma Parvan; Chapter 40; verses 40-47. The *Mahābhārata,* Critical Edition, BORI, Poona.

[56] मित्रावरुणौ त्वोत्तरतः परिधत्तां ध्रुवेण धर्मणा॥ *TS* (I. 1.11.12)

times, since the practitioners did not limit themselves to physical observations but wished to attain a position in the sky. This mystical naturalism gets highlighted by the role of the Brahman, the presiding priest of the DP rite, who blesses the sacrificer silently

> ...नाकस्य पृष्ठे यजमानो अस्तु। सप्तऋषीणां सुकृतां यत्र लोकस्तत्रेमं यज्ञं यजमानं च धेहि ॥
> may the *yajamāna* attain a place at the base of the heaven, near the constellation *Saptarṣi*.

The northern sky region around the *Saptarṣi-maṇḍala* (U. Major) has always held prominent position in ancient texts as the base of the heaven and the centre of the universe. This region was the seat of another constellation known as *Śiśumāra*, about which will be discussing in the following section.

5 *Śiśumāra* the forgotten northern constellation with *Dhruva*, the Vedic Hindu pole star

Al-Bīrūnī (973–1048 CE) in his book on India mentions that devout Hindus held that the pole star was in the constellation that looks like a four-footed aquatic animal called, *Śākvarā* and also as *Śiśumāra.*[57] He further says that this name sounds similar to the Persian Susumar, which is the constellation of the Great Lizard, same as the modern Draco. He further adds that "the Hindus tell ludicrous tales about this figure." By this, he alludes to the *Purāṇas* that praise people with correct knowledge of the 14 stars making up the constellation to be blessed with an extra 14 years of life. Al-Bīrūnī, as is well known, was interested in the philosophical and intellectual traditions of India. He translated into Arabic, apart from astronomical texts, the *Yogasūtra* of Patañjali. While explaining the aphorism; *dhruve tadgati jñānam* (YS 3.29) Al-Bīrūnī again discusses the constellation *Śiśumāra* and *Dhruva* the pole star, as per the ancient Hindu tradition prevalent during his time.[58] Al-Bīrūnī had admiration for Indian astronomers because of their scientific approach to the subject. But, none of the *siddhānta* texts of the period described any constellation by the name *Śiśumāra.* Curiously enough, they were much more interested in establishing the first visibility conditions for the southern star *Agastya* (Canopus). This should not be surprising, since there was no visible star at the North Celestial Pole (NCP) during the first millennium of the common era (CE) which was the prime period of mathematical astronomy in India. This situation perhaps prompted Al-Bīrūnī not to take the *Purāṇas* seriously as having preserved more ancient observations, in the form of legends and cultural beliefs. However, common people carried in their collective memory the story of a child prince by name *Dhruva* who was established as the

[57] Sachau E. C. *Alberuni's India: An Account....of India About* AD *1030.* (Vols. I & II) London. 1910.

[58] Pines S. and Gelblum T. *Alberuni's Arabic Version of Patanjali's Yogasutra: A Translation of the third chapter and comparison with Related Texts.* Bull. School of Oriental and African Studies, Univ. of London, 2, pp. 258-304, 1983.

fixed pole star and the *Purāṇas* had already built up a cosmological sky model around *Dhruva.* The orthodox Vedic tradition of the *Vedāntins*, cultivated in parallel also held that *Dhruva* the pole star was located in the constellation *Śiśumāra.* From modern astronomy, it is known that such a situation was possible in the remote past c 3000 BCE, when α-Draconis (Thuban) was the pole star. Recognition of this fact has far reaching consequences for understanding the history of ancient India and of Hindu astronomy going back to Vedic times.

In this article, Vedic literature is considered first, followed by the *Purāṇas* and a few later texts. The information thus collected brings out some aspects of *dhruva*–centric or pole-centric astronomy that must have existed in India before the common era.

5.1 *Taittirīya Āraṇyaka*

The word *dhruva* occurs in many places starting from the *Ṛgveda.* The accepted meaning of this word is fixed, true, stationary, unchanging with shades of meaning very similar to these. For example in the *Ṛgveda* hymns (I. 73, IV. 5, VI. 52, VII. 88, X. 173) the word is used as an adjective to indicate the firmness of objects such as the earth, the mountain, and the sky. In the 10th book the hymn X. 173 extols Varuṇa the King, as being true and steadfast. From the context of the hymn, this appears to be a prayer to a universal force, with the sky and most likely a star in the background. In the *Yajurveda* and the *Atharvaveda*, eight and sometimes ten directions are named. In this nomenclature invariably *udīci* stands for north, *ūrdhva* for above and *dhruvā dik* refers to the lower direction in the sense of fixed earth. However, in the *Taittirīya Āraṇyaka* (*TA*) a change in this nomenclature is seen. The phrase *adharāyai diśe* (*TA* II.20.1) instead of the more common *dhruvāyai diśe*, is used to denote the lower direction.

The *TA* is an accented Vedic text, belonging to the *Kṛṣṇa-Yajurveda* branch. This text contains several interesting astronomical information that should be of interest to historians of science. The first *praśna* (section) of the text is about the six seasons and how they have to be recognized, taking note of social behavior and some natural changes. Time is explained as flowing out of the sun and that time flows like a river continuously (*TA* I.2). The text declares the knowledge of the sun's position to be available to everyone using the four tools; memory, direct observation, history and inference.

स्मृतिः प्रत्यक्षमैतिह्यम्। अनुमानश्चतुष्टयम्। एतैरादित्यमण्डलम्। सर्वैरेव विधास्यते॥ *TA* (I.2.1)

As pointed out previously in Section 2 of this article, two meteoritic showers spaced at six months intervals find place (*TA* I. 3; I.4) in recognizing the *grīṣma* (summer) and the *hemanta* (dewy) seasons. The concept of *mahāmeru* the imaginary mountain-like axis connecting earth with the heavens appears for the first time in Vedic literature in *TA*. The text alludes to seven suns and

one more, the eighth called *Kaśyapa,* who does not leave *meru* but goes round the *mahāmeru.*

कश्यपोऽष्टमः। स महामेरुं न जहाति। ...न हि शेकुमिव महामेरुं गन्तुम्।
अपश्यं अहं एतत् सूर्यमण्डलं परिवर्तमानम्। गार्ग्यः प्राणत्रातः। गच्छन्त महामेरुम्॥
TA (I. 7.1-3)

This concept of a celestial body going round *meru* evolved into a physical astronomical model in the *Brahmāṇḍa Purāṇa* as will be explained later.

We have seen previously that the performer of the *darśapūrṇamāsa* sacrifice wishes to be stationed near *Saptarṣi* at the base of the heavens. This esoteric concept finds unambiguous mention in *TA* where it is stated that *the Seven Sages and Agastya are living with the stars.*[59] This tradition of naming stars, we may presume, must have started after the earthly sojourn of the eponymous human *ṛṣis.* Hence, it would be of interest to identify such stars by their modern names. Through unbroken tradition, and copious textual citations, *Agastya* can be equated with Canopus. But the same cannot be done with the other seven stars, since the names of the sages are not mentioned in TA except for Atri. The commentators of *TA* have taken the Seven Sages and *Agastya* to be the originators of the *gotra* system, as mentioned in the later *Sūtra* literature.

विश्वामित्रो जमदग्निर्भारद्वाजोऽथ गौतमः। अत्रिर्वसिष्ठः कश्यप
इत्येते सप्तर्षयः। सप्तानां ऋषीणां अगस्त्याष्टमानां यदपत्यं
तद्गोत्रमित्याचक्षते॥ (*Āśvalāyana Śrautasūtra Pariśiṣṭa*)

Hence it is not necessary to identify the Seven Sages alluded to in *TA* only with the stars of U. Major, even though such equivalence appears natural. The *Saptarṣi-maṇḍala* is unequivocally identified with U.Major, but the tradition of *ṛṣi*-names of the stars has changed over time.[60] The name of sage Atri once again appears in *TA* as a star in the description of the celestial *Śiśumāra,* a constellation in the form of an aquatic animal (alligator, or whale or dolphin), with a star named *Abhaya* at its tail end, which over time acquired the legendary name *Dhruva*, due to its property of being fixed in position as seen from earth.

5.2 The celestial *Śiśumāra*

The second book (*prapāṭhaka*) of *TA* known also as the *Svādhyāya Brāhmaṇa*, gives the hymns used in the daily prayers of those initiated into the Vedic rites. The nineteenth hymn of this book known as the *Brahmopasthānamantra* is used at the conclusion of the evening meditation, which in the most ancient times was carried out outdoors most probably near a water body. The astronomical part of the text with a free translation follows:

[59] ऋषयस्सप्तात्रिश्च यत्। सर्वेत्रयो अगस्त्यश्च। नक्षत्रैश्शङ्कृतोऽवसन्॥

[60] Mitchiner J. E., *Traditions of the Seven Ṛṣis,* MLBD New Delhi, 2000.

धर्मो मूर्धानं ब्रह्मोत्तराहनुः यज्ञोऽधरा विष्णुर्हृदयं संवथ्सरः प्रजननं अश्विनौ पूर्वपादावत्रिर्मध्यं मित्रावरुणवपरपादावग्निः पुच्छस्य प्रथमं काण्डं तत इन्द्रस्ततः प्रजापतिरभयं चतुर्थं स वा एष दिव्यश्शाक्वरश्शिशुमारः। ... ध्रुवस्त्वमसि ध्रुवस्य क्षितमसि त्वं भूतानामधिपतिरसि त्वं भूतानां श्रेष्ठोऽसि त्वां भूतान्युपपर्यावर्तन्ते नमस्ते नमः ... शिशुकुमाराय नमः॥ (TA. II.19.1)

...*Dharma* is the forehead, Brahma is the upper jaw, *Yajña* is the lower jaw, Viṣṇu is the heart, *Samvatsara* is the genital, *Aśvins* are the forelegs, Atri is the center, Mitra and Varuṇa are the hind legs. *Agni* is the first stem of the tail, then Indra, then Prajāpati and then *Abhayam* is the fourth. This is the shining celestial *Śiśumāra*.... You are fixed (*dhruva*), you are the place of *Dhruva*...You are the Lord of Beings; you are the best among them. (All) Beings go around you. *Namaste!*...salutations to you the boy–child.

The commentary of Sāyaṇa clearly mentions that this hymn is to be used in the evening, turning towards the north and looking at the *dhruva–maṇḍala*, for meditating on the Cosmic Brahman.[61]

The above hymn lists fourteen stars, Dharma, Brahma, *Yajña,* Viṣṇu, *Samvatsara,* (Twin) *Aśvins*, Atri, Mitra, Varuṇa, Agni, Indra, Prajāpati, Abhaya, along the body of the figure of the *Śiśumāra,* starting from its head to the end of its tail, unequivocally said to be in the sky. Both Bhaṭṭa-bhāskara (10th Cent.) and Sāyaṇa (14th Cent.) describe the esoteric import of the hymn, along with the parts and form of the animal figure in the sky. The former commentator takes Prajāpati to be Kaśyapa the eighth sun, mentioned previously in *TA* as not leaving the *meru.*[62] This hints at the circumpolar nature of at least some of the stars of this constellation, which finds prominent mention in the later *Purāṇas.* The hymn is more about the constellation figure as a group of stars, but the equivalence of *Abhaya* with the pole star later known as *Dhruva* is evident from the context. The text of *TA* is among the so called forest books supposed to be learnt in the seclusion of a forest, as it contains secret mystical and naturalistic meanings at the same time. The play on the word *Śiśumāra* finally concluded as *śiśukumāra* (boy-child) should have been the inspiration for the legend of the fearless child prince *Dhruva,* placed in the sky as the pole star near Viṣṇu, who is the regent deity at the heart of the *Śiśumāra.*

In the accented text *Ekāgni-kāṇḍa,* also belonging to the *Kṛṣṇa-yajurveda*, hymns to be used in Vedic marriage rites are given. The hymn for observing and addressing the pole star *Dhruva* is:

ध्रुवक्षितिः ध्रुवयोनिः ध्रुवमसि ध्रुवतस्थितम्।
त्वं नक्षत्राणां मेथ्यसि स मां पाहि पृतन्यतः॥ *Ekāgni* (I. 9)

[61] अनेन मन्त्रेण उदङ्मुखो भूत्वा ध्रुवमण्डलं पश्यन् शिशुमाररूपेण तमुपतिष्ठेत्॥ Sāyaṇa's Commentary on TA (Edited by H. N. Apte, Anandashrama Press, Pune, 1898).

[62] *Taittirīya Āraṇyaka* with the Commentary of Bhaṭṭabhāskara Miśra (Edited by A. M. Shastri and K. Rangacharya. Mysore 1900).

Here the quality of *Dhruva* as a star is said to be fixed. *Dhruva* is praised as the *methī* or the fixed column to which the *nakṣatras* are bound. The commentator *Haradatta* explains the word *methī* as *khalevālī,* a thick wooden peg fixed in the ground, to which animals are tied so that they do not stray away.[63] This *methī* became the *meḍhī* a pole or column in the *Purāṇas*, highlighting the fixity of the star *Dhruva* and the importance of *Meru* in the development of early astronomical models. As we go back in time naturally uncertainties increase, but beyond reasonable doubt the composers of the above *Yajurveda* texts knew *Abhaya* alias *Dhruva* as the pole star; that is a central star farthest in the sky, to which other celestial bodies were tied and kept in their path.

The *Śiśumāra*, which we meet again in the *Purāṇas,* based on the vivid description of the position of the 14 stars and the importance attached to its form, can be identified with the constellation Draco. It follows: *Dhruva* in its earliest nomenclature as *Abhaya* has to be equated with Thuban or α–Draconis. By back computations it is known that α-Draconis was the pole star during 3200-2400 BCE. In this long period, the declination of this star varied from $87°56'$ to $87°36'$, reaching nearest to NCP with $89°53'$ in 2830 BCE. The naming of the Vedic star *Abhaya* (no-fear) as *Dhruva* (fixed, certain) in the *Śiśumāra* should have happened during the above period, which provides an important chronological footprint not only for the Vedic culture but also for the roots of Hindu astronomy. By 1900 BCE the separation of *Dhruva* from NCP increased to 5 degrees and the circumpolar nature of the star would have been evident to observers of the night sky. The declination changed to nearly 82° by 1500 BCE and the drift of the star away from the NCP should have been glaringly evident for observers in India. In the *Maitrāyaṇī Āraṇyaka Upaniṣat (aka Maitrī Upaniṣat, MAU)* one of the important questions posed by King Bṛhadratha to Sage Śākāyanya was, why *Dhruva* drifts, why the air strings holding the celestial bodies *dip*.

> किमेतैर्वान्यानां शोषणं महार्णवानां शिखरिणां प्रपतनं ध्रुवस्य प्रचलनं व्रश्चनं वातरज्जूनां निमज्जनं पृथिव्याः स्थानादपसरणं...॥ *MAU* (I.4)

Implicit in this question is the statement: the North Star understood by us as fixed has changed its position; an unmistakable reference to the effect of precession as noticed by King Bṛhadratha. This *Yajurvedic* text also contains astronomical statements to the effect that the northern course of the sun started at the middle of the *dhaniṣṭhā* star division.

> सूर्यो योनिर्वै कालस्य। तस्यैतद्रूपं यन्निमेषादिकालात् सम्भृतं द्वादशात्मकं वत्सरस्य आग्नेयमर्धमर्धं वारुणं मघाद्यं श्रविष्ठार्धमाग्नेयम्। क्रमेणोत्क्रमेण सार्पाद्यं श्रविष्ठार्धान्तं सौम्यम्॥ *MAU* (VI. 14)

This corresponds to a few centuries before the *Vedāṅga Jyotiṣa* of Lagadha which states that the winter solstice coincided with the sun at the beginning of

[63] *Ekāgnikāṇḍa with the Commentary of Haradatta* (Edited by L. Srinivasacharya). G.O.L. Mysore 1902

star *dhaniṣṭhā.* This is a well discussed topic with the said observation dateable to c 1400 BCE.[64] The amount of precession between the two observations would be six to seven degrees. Thus, the drift of the pole star mentioned by King Bṛhadratha above is broadly consistent with 1900-1800 BCE.

The knowledge of *Śiśumāra* as a constellation, in contrast to the word meaning as an aquatic animal, is wide spread in Vedic literature. In the first book of the *Ṛgveda* (I. 116.18) we come across *Aśvins* bringing riches to *Divodāsa* in a cart to which were yoked a *śimśumāra* and a *vṛṣabha.* Griffith famous as the translator of *RV*, overlooking the astronomical culture of the *Vedas*, has translated this literally to mean a cart drawn by a porpoise and a bull yoked together.[65] In the commentary of Sāyaṇa, the word *śimśumāra* is identified as a variant of the word *Śiśumāra.* Sāyaṇa also recognizes the impossibility of an aquatic animal and a land animal yoked to drag a cart on earth and explains this as the special act of the divine twins the *Aśvins* exhibiting their extraordinary powers,[66] which obviously makes the location to be the visible sky. Even if *Divodāsa* were to be a human king, favouring whom the above is mentioned, it should not be difficult to recognize that the verse alludes to an event in the sky in which the constellations Draco and a group of stars resembling the head of a bull, most likely the Taurus, were meant by the poet.

The *Pañcavimśa Brāhmaṇa* of the *Sāmaveda* has an interesting story about the cosmography behind the name *Śiśumāra.* It is said that originally this was a *Ṛṣi* or seer of the same name in the earthly ocean. He did not praise Indra fully and hence got stranded on the sands. After having praised Indra fully by the *śarkara sāman* song he could get into the water again. Later he attained the sky as the constellation with the same name. The word *śarkara* means constellation which is a variant of the word *śākvara* as in *TA*. The text further says that the *śarkara sāman* chant is meant for crossing the oceans.[67] This has to be taken as a reference to the circumpolar nature of the bright stars of the *Śiśumāra* constellation which must have helped ancient mariners in navigating the seas. The *Jaiminīya Brāhmaṇa* text also has a similar legend about the constellation *Śiśumāra.* The *Gṛhyasūtra* texts which were fixed much later than the accented core Vedic texts are prescriptive in nature about religious rites and customs to be followed by the orthodox. The religious practices of different Vedic clans which must have been prevalent since the most ancient

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[64] *Vedāṅga Jyoutiṣa of Lagadha* (Ed. by T. S. K. Sastry) IJHS, 19.4. Supplement, 1-74. N. Delhi. 1984.

[65] *When to his house ye came, to Divodāsa, hasting to Bharadvāja, O ye* Aśvins, *The car that came with you brought splendid riches: a porpoise and a bull were yoked together.* (*RV* I.116.18; Translation by Griffith R. T.)

[66] तस्मै दिवोदासाय प्रापयामास। अपिच तस्मिन् रथे वृषभः अनड्वान् शिंशुमारः ग्राह च परस्परविरुद्धावपि स्वसामर्थ्यप्रकटनाय युक्ता वाहनतया सम्युक्तावास्ताम्॥ (Commentary of Sāyaṇa, *RV* I.116)

[67] Caland W. English Translation of the *Pañcavimśa-Brāhmaṇa,* Bibliotheca Indica Series, 255, Calcutta, 1932.

times are codified in the formulaic *Sūtra* literature, not only canonizing the hymns to be used in the rites, but also fixing the actions to be followed by the main performers, participants and the priests. There are several different *Sūtra* texts attached to the four *Vedas* demonstrating not only their lateness, but also their spatial spread in accounting for the variation in the practices. However, the common feature of all these texts, in the historical context, is their memory of *Dhruva* as a fixed star to be invoked, seen and shown to the bride in the marriage rite. In all cases, the hymn for addressing *Dhruva* is same as or very similar to the one in the *Ekāgni-kāṇḍa* (I.9) mentioned above. The *Hiraṇyakeśi Gṛhyasūtra*, in particular, prescribes worship of stars *Arundhatī, Saptarṣi*, and *Dhruva* even during the first kindling of the fire used in Vedic sacrifices. This text extols the pole star as, Brahman, fixed, non-slipping, non-shaking and as the centre of the universe.

It is noted that the Vedic people had direct knowledge of the constellation with fourteen stars, resembling in its outline an aquatic animal known as *Śiśumāra,* the 14th star counted from the head and placed on its tail being the fixed *Dhruva* or the pole star. The effect of precession on the sky picture was also felt as recorded in the *Maitrāyaṇīya* text, where *Dhruva* was observed to be drifting away from its original position. Notwithstanding, such natural effects, the formality of showing the star *Dhruva* has continued in Hindu marriages over centuries coming down in the same form to this day as a ritual, even though everyone may not know which star was originally invoked by the prescribed hymns. But the orthodox successors to the Vedic tradition have preserved this information quite correctly as will be seen later.

It has to be pointed out here that the not so well known Indian scholar Aiyangar,[68] in his writings on Indo-Aryan mythology discussed the *TA* hymn on *Śiśumāra* as representing a constellation in the sky and hesitatingly proposed that the *Dhruva* of this hymn was perhaps the pole star. He was more interested in gathering and deriving philosophical information from the Vedic and *Purāṇa* stories. He did not recognize the constellation *Śiśumāra* in astronomical terms but drifted widely to other astral myths in an effort to match the Vedic and the Purāṇic stories without appreciating the effect of precession as recorded in the astral legends.

5.3 *Brahmāṇḍa Purāṇa* (BP)

This tradition of observing *Śiśumāra* and *Dhruva* was not restricted to the closed Vedic groups but was available to everyone as depicted in the *Purāṇas*, which have preserved such observational knowledge in the form of cultural astronomy. The story of the young boy *Dhruva*, who by his penance got the boon of being fixed in the north as the pole star, is a popular legend widely

[68] Aiyangār M. N. *Essays on Indo-Āryan Mythology,* Bangalore 1898. Available at: (https://archive.org/details/MN40106ucmf_3)

known all over India. The origin of this story can be traced to the *ViṣṇuPurāṇa* (VP) and repeated in several other texts. However, the related background astronomy is preserved in the *Brahmāṇḍa Purāṇa* without mythological embellishments. Since the word *Dhruva* means fixed, certain, unchanging, it is implicit that the boy *Dhruva* was identified with the eponymous pole star. This fact becomes interesting since BP, VP and several other texts not only provide cogent information on its location in the sky but also mention the observable self-rotation of *Dhruva* as the driving force for other celestial bodies to move around the NCP. This theory of *Dhruva*, takes us to the most ancient form of Indian astronomy which was *Dhruva-centric*, or *meru-centric.* It is known that no absolute dates can be put forth for any of the eighteen *Purāṇa* texts, which have grown over time with bulky additions. But, all or most of them retain the story of *Dhruva* as the pole star with variant readings. This is a clear indication of the branching of the *Purāṇas* from a nucleus which lies in the Vedic texts such as the *TA* and the *ekāgni-kāṇḍa* which knew the prominent constellation *Śiśumāra* with 14 stars, the fixed *Dhruva* and the *Meru* connecting the earth with the NCP. Among the *Purāṇas* it is in BP we find matter of fact statements about *Dhruva.* As far as ancient astronomy and cosmology are concerned, BP preserves the original concepts, out of which the *Viṣṇu, Vāyu, Liṅga* and *Matsya Purāṇa* have bifurcated with further variations. This chronological perspective finds support in the works of a few indologists also.[69]

The *Dhruva-centric* model of the sky can be best appreciated in the BP as an outcome of direct observation. We consider here BP first and later look at variant information from a few other texts. In the first chapter of BP a list of the contents to be covered is provided. This promises astronomy related to *Dhruva* as,

> सूर्यादीनां स्यन्दनानां ध्रुवादेव प्रवर्तनम्।
> कीर्त्यते शिशुमारश्च यस्य पुच्छे ध्रुवः स्थितः॥ BP. I (1.84)
>
> The movement of the sun and other moving celestial bodies is explained as induced by *Dhruva* only. The constellation *Śiśumāra*, at the tail of which *Dhruva* stays, is also described.

This theory is further elaborated in chapters 21-24, totaling 520 verses, with many ancient concepts about the sun, the moon, eclipses and planets. Here, we restrict our attention only to a few important statements concerning *Śiśumāra* and *Dhruva.*

> ततो मन्दतरं नाभ्यां चक्रं भ्रमति वै तथा। मृत्पिण्ड इव मध्यस्थो ध्रुवो भ्रमति वै तथा॥
> त्रिंशन्मुहूर्तानेवाहुः अहोरात्रं ध्रुवो भ्रमन्। उभयोः काष्ठयोः मध्ये भ्रमते मण्डलानि तु॥
> कुलालचक्रनाभिश्च यथा तत्रैव वर्तते। ध्रुवस्तथाहि विज्ञेयः तत्रैव परिवर्तते॥
> hspace*3pt BP. I (21. 94, 95, 96)

[69] Clarke W. E., *A note on Pargiter's Ancient Indian Historical Tradition*, J Am. Ori. Soc, 43, pp. 130-131, 1923.

> Like the lump of clay at the middle of the [potter's] wheel moves slowly sitting at the navel, *Dhruva* rotates. *Dhruva* moves in circles day and night consisting of 30 *muhūrtas*, at the middle of the two directions (north and south). Like the navel of the potter's wheel which stays in the same place, so also *Dhruva* should be known to be rotating there itself.

Chapter 21 containing 176 verses gives an account of the sun's motion, with definitions of seasons, equinox and solstice. It introduces the cosmography of *Mt. Meru* connecting the earth and the heavens like a vertical pole in the north, around which all celestial bodies are modeled to move in circular paths. The star *Dhruva* is said to be at the tip of the *Meru.* The starry space in the sky between the *nakṣatras* of *ajaveethi* and star *Agastya* (Canopus) is said to be the *pitṛloka* (abode of manes), where as the corresponding region in the north between *nakṣatras* of *nāgaveethi* and *Saptarṣi* (U. Major) is the *devaloka* (abode of gods).[70] The chapter ends by declaring the famous third step of Viṣṇu to be in the north above the *Saptarṣi* wherein *Dhruva, Dharma* and others are located.[71]

Chapter 22 starts with a description of the position of *Dhruva* as

> भूतसम्मोहनं ह्येतद् वदतो मे निबोधत। प्रत्यक्षमपि दृश्यं च सम्मोहयति यत् प्रजाः॥
> योऽयं चतुर्दशर्क्षेषु शैशुमारे व्यवस्थितः। उत्तानपादपुत्रोऽसौ मेढीभूतो ध्रुवो दिवि॥
> स वै भ्रामयते नित्यं चन्द्रादित्यौ ग्रहैः सह। भ्रमन्तमनुगच्छन्ति नक्षत्राणि च चक्रवत्॥
>
> BP. I (22. 5, 6, 7)

> Listen to this explanation of mine which is real and observable but mystifying people. He, who is at the tail of the 14 stars looking like a *śiśumāra; Dhruva* the son of *Uttānapāda*, has become the main pivot of the pole in the sky. Verily, he rotates the sun, the moon and the planets continuously. The stars follow him who is himself circling like a wheel.

In the above the narrator (*Sūta*) is appealing to people to observe the sky and understand the ancient theory of *Dhruva* as the controller of the motion of the celestial bodies. Since *Dhruva* as a north star is said to be in a figure looking like a *śiśumāra,* this group of stars should be the same as the constellation meant by the Vedic texts discussed already. BP further elaborates the self-circling motion of *Dhruva* and that of the stars (*tārāḥ*) and the *nakṣatras* around him. The point to be noted is the differentiation between the general stars and the *nakṣatras.* The latter are the 27 ecliptic asterisms and *Dhruva* was never one among them. There are 84 verses in this chapter, arguing for a physical model for the motion of the sun seen in the day but, linked to *Dhruva* seen only in the night. The northern and southern sojourn of the sun

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[70] उत्तरं यदगस्त्यस्य ह्यजवीथ्याश्च दक्षिणम्। पितृयाणः स वै पन्थाः वैश्वानरपथाद्बहिः॥
नागवीत्युत्तरोयश्च सप्त ऋषिगणदक्षिणः। उत्तरः सवितुः पन्था देवयानश्च स स्मृतः॥ BP (21.156) and BP (21.168)

[71] ऊर्ध्वोत्तरं ऋषिभ्यस्तु ध्रुवो यत्र स वै स्मृतः। एतद्विष्णुपदं दिव्यं तृतीयं व्योम्नि भास्वरम्॥
यत्र गत्वा न शोचन्ति तद्विष्णोः परमं पदम्। धर्मध्रुवाद्याः तिष्ठन्ति यत्र ते लोकसाधकाः॥ BP (21.175, 176)

also had to be explained within this model. Without going into the details, we note that the sun's chariot is said to have only one wheel, the axle of which is connected to *Dhruva* by two strings of light which take care of the change in the orbit of the sun around the earth. We speculate that the older analogy of the potter's wheel was unable to mimic the observed apparent motion of the sun and hence the two axle model and connection to *Dhruva* with two unseen strings was proposed to simulate action at a distance. This change is also seen in the example of the animal driven oil mill proposed as a physical model for understanding the motion of the stars around *Dhruva.*

यावत्यश्चैव ताराश्च तावन्तो वातरश्मयः। सर्वा ध्रुवे निबद्धाश्च भ्रमन्त्यो भ्रामयन्ति ताः॥
तैलपीडा यथा चक्रं भ्रमन्तो भ्रामयन्ति ह। तथा भ्रमन्ति ज्योतींषि वातबद्धानि सर्वशः॥
BP. I (23.96, 97)

There are as many wind-reins as there are stars. All (reins) are bound to *Dhruva;* themselves rotating, they make the stars to go round. As in an oil press, the wheel goes round and makes the other (the pole) rotate; so too the luminaries, held in grip by the wind-strings, revolve.

Fig. 4: Traditional oil mill

In the oil mill, the central pole is rotated by the motive force provided by an animal moving in a circular path. In the Purāṇic sky model, the roles are reversed, such that the locally spinning *Dhruva* can make the celestial bodies at a distance to move around in their circular path, the connection being through strings (or rays) of wind (or light).

Chapter 23 of BP is indispensable to anyone interested in the history of Indian astronomy as it explains the astronomical symbolism behind the lunar number 3339, first appearing in the *Ṛgveda.*[72] Towards the end of this chapter the text describes the location of *Dhruva* along with other companion stars making up the animal figure *Śiśumāra.*

एवं ध्रुवनिबद्धोऽसौ सर्पते ज्योतिषां गणः। सैष तारामयः प्रोक्तः शिशुमारो ध्रुवो दिवि॥
यदह्ना कुरुते पापं दृष्ट्वा तन्निशि मुञ्चते। यावत्यश्चैव तारास्ताः शिशुमाराश्रिता दिवि॥
तावन्त्यैव तु वर्षाणि जीविताभ्यधिकानि तु। साकारः शिशुमारश्च विज्ञेयः प्रविभागशः॥
BP. I (23. 99, 101b)

Thus, centered in *Dhruva*, the circle of luminaries revolves. And this *Śiśumāra*, fixed in the sky, is to be understood as made of stars. Whatever sin one commits during day, one is divested of it upon seeing *Śiśumāra* in the night. As many stars as there are associated with *Śiśumāra* in the sky, so many years more, does one live on. (For this) the form of the *Śiśumāra* should be known in terms of its parts.

The chapter ends with a good description of the *Śiśumāra* constellation enumerating the constituent stars numbering fourteen. This is perhaps the earliest example of a star group being represented and named by an animal figure.

उत्तानपादस्तस्याथ विज्ञेयः सोत्तरा हनुः। यज्ञोऽधरस्तु विज्ञेयो धर्मो मूर्धानमाश्रितः॥
हृदि नारायणः साध्यो अश्विनौ पूर्वपादयोः। वरुणश्चार्यमा चैव पश्चिमे तस्य सक्थिनी॥
शिश्नं संवत्सरस्तस्य मित्रश्चापानमाश्रितः। पुच्छेऽग्निश्चमहेन्द्रश्च मारीचः कश्यपो ध्रुवः॥
तारकाः शिशुमारस्य नास्तं याति चतुष्टयम्॥ अग्नीन्द्रकश्यपानां तु चरमोऽसौ ध्रुवः स्मृतः॥
BP. I (23. 102-104, 105b, 107b)

His (*Śiśumāra's*) upper jaw should be understood as *Uttānapāda. Yajña* (*Kratu*) is known as the lower jaw and *Dharma* as the head. At the heart is *Nārāyaṇa (Sādhya).* The twin *Aśvins* occupy the forelegs while *Varuṇa* and *Aryamā* are at the hind legs. *Samvatsara* is the genital and *Mitra* occupies the seat. In the tail are *Agni, Mahendra, Mārīca-Kaśyapa* and *Dhruva.* The (previous) four stars of the *Śiśumāra* never set. It is remembered that *Dhruva* is the last star after *Agni*, *Indra* and *Kaśyapa.*

This listing of stars on the body of the *Śiśumāra* is almost same as in *TA* with minor variations in the names, but the geometrical picture of the animal figure is same as in *TA*. The "addition of 14 years of life" which Al-Bīrūnī found not rational, was a ploy of the narrator when BP was still orally transmitted, for encouraging people to observe and preserve the names of the constituent stars and the form of the constellation accurately.

5.4 *Viṣṇu Purāṇa* (VP)

The *Viṣṇu Purāṇa* one of the important religious texts relates the earthly story of *Dhruva* with poetic embellishments and devotional fervour. In the BP the boon for *Dhruva* to be in the sky as the pole star is given by Brahma, where as in the VP, *Viṣṇu* is said to give the boon. Interesting astro-mythological

[72] See previous section 2 and 3 of this article.

information provided in the VP is that *Dhruva's* mother *Sunīti* stays near him in the sky as a companion star. This provides a constraint on the identification of *Dhruva* in the *Śiśumāra* constellation. In the description of the stars making up the constellation fourteen are mentioned as in BP. The only difference being the word *mārīcaḥ* qualifying *Kaśyapa* is missing in VP. The cosmological functions assigned to *Dhruva* in the VP are same as in BP. Both mention *Dhruva* as the fourth after *Agni* and the last four stars ending with *Dhruva* do not set. The *Matsya* and the *Vāyu Purāṇa* repeat similar astral information with a few deletions, about *Dhruva* and *Śiśumāra.*

5.5 *Bhāgavata* and *Devībhāgavata*

The *Bhāgavata* is again a highly respected text mainly extolling devotion to Viṣṇu and his incarnations. Many of the statements in this text about *Dhruva* that are in prose form (Book V. Ch. 23) are same as in VP but not all the fourteen stars of the *Śiśumāra* are named. *Dhruva* is initially associated with stars *Agni, Indra, Prajāpati, Kaśyapa* and *Dharma* and is compared to a fixed object or pillar around which heavenly bodies rotate driven by time. *Dhruva* rotation as the driving force is conspicuously absent in this text. Further the text quite categorically states that some people meditate on the figure of *Śiśumāra* as the body of Vāsudeva. These people are said to think of *Dhruva* at the end of the tail; *Prajāpati, Indra, Agni* and *Dharma* on the trunk of the tail, *Dhāta* at the root of the tail and *Saptarṣi* (U.Major) at the waist. The text further describes how the coiled figure has to be imagined with the sun, the moon, stars and all the planets at the various places of its universal body.[73]

In the *Devībhāgavata* the description of *Dhruva* is an exact restatement of the *Bhāgavata* in verse form. Here also some people are said to imagine the *Śiśumāra* constellation in an extended form to cover the whole sky as the divine body of Viṣṇu (8.18; v. 11-26). Whatever may be the inspiration for this extension, it is easy to observe that these texts lack the care and detail with which BP describes its *Dhruva-centric* astronomy. The texts that are liberal with religious concepts at the cost of astronomical pictures can be easily recognized as being chronologically later, when the original *Dhruva* was not at the NCP.

5.6 The *Śiśumāra* constellation

The constellation of *Śiśumāra* consisting of fourteen observable stars that make up a figure like a dolphin (or porpoise or alligator) is well preserved in the Vedic and the Purāṇic texts. The *Pañcavimśa Brāhmaṇa* of the *Sāmaveda*, already discussed indicates that the circumpolar property of the bright stars

[73] केचनैः तज्ज्योतिः अनीकं शिशुमारसंस्थानेन भगवतो वासुदेवस्य योगधारणायां अनुवर्णयन्ति॥

of this constellation was of help in navigation. The celestial ocean in which the constellation is said to rise and move can be recognized as the Milky Way, which BP calls *viyadgaṅgā* or the heavenly Gaṅgā River. With all the above details, recognition of this constellation as the modern Draco should be obvious. However, Allen[74] in his classical book on star names gives two meanings to *Śisumāra* namely, Draco and Delphinius, the latter meaning attested nowhere in the ancient literature. The reason for this can be traced to the faulty rendering of original Sanskrit texts in popular translations.

For example the vulgate *Matsya Purāṇa* has a footnote that makes *Śiśumāra* to mean the zodiac personified and no other than the child Viṣṇu.[75] In his translation of the *Viṣṇu Purāṇa,* Dutt[76] takes fancifully *Śiśumāra* in one place as the stellar sphere. Even the modern translation of the *Brahmāṇḍa Purāṇa* by Tagare[77] adds an unnecessary footnote citing the *Bhāgavata* that all the stars and constellations are located as different parts of the body of this heavenly porpoise. However, as seen previously the *Bhāgavata* mentions that some people for meditation follow such a procedure and as far as the BP text is considered such an interpretation is impossible. As per the original texts in the BP and the VP there is no way to conceive the constellation other than placing the fourteen stars on the outline figure of a *Śiśumāra* for its visual picture. The statement that four of the stars on the tail, with *Dhruva* as the fourth do not set, clearly makes these circumpolar, for the observer and narrator Sūta of BP. The one to one correspondence between the Vedic and the Purāṇic description leads us to the conclusion that the constellation meant should be the Draco in the northern sky.

Referring to Figure 5, the ancient description stopped with α–Draconis (Thuban) without including stars –and λ– Draconis. The names of some of the Vedic stars can be tentatively identified with their modern equivalents. Behind α–Draconis (Thuban) are ι, θ, η stars that can be recognized as *Prajāpati, Indra* and *Agni*. The name *Saṃvatsara* literally Year, for one of the stars (5th or 6th from *Dhruva*) is interesting. It is said to be the genital, meaning thereby in Vedic parlance, the producer of Years. It would be interesting to investigate this further to see whether a star of this constellation which exhibited visibility phenomena could have been used as a marker for recognizing the beginning of the New Year in the 3rd millennium BCE. The stars *Dharma* and Brahma of *TA* can be identified as γ–and β–Draconis (magnitude 2.24 and 2.79) respectively. The *Purāṇas* changed Brahma to *Uttānapāda* so that

[74] Allen R. H. *Star Names and Their Meanings,* Dover Publications. Inc., USA. 1963

[75] The *Matsya Purāṇa* (Text and Transl by H. H. Wilson) Arranged by N. S. Singh, Nag Publ. New Delhi, 1997

[76] Dutt M. N. *English Translation of the Viṣṇu Purāṇa,* Chowkamba Publ.Varanasi. 1972.

[77] Tagare G. V. *English Translation of the Brahmāṇḍa Purāṇa*, Motilal Banarsidas Publ. New Delhi, 2000.

his son *Dhruva (*Abhaya*)* remains at the end of the same figure, along with his mother Sunīti identifiable as star 10-Dra of magnitude 4.5. The forelegs with the two *Aśvins* and hind legs with *Mitra* and *Varuṇa* are identifiable as the two bends in the figure.

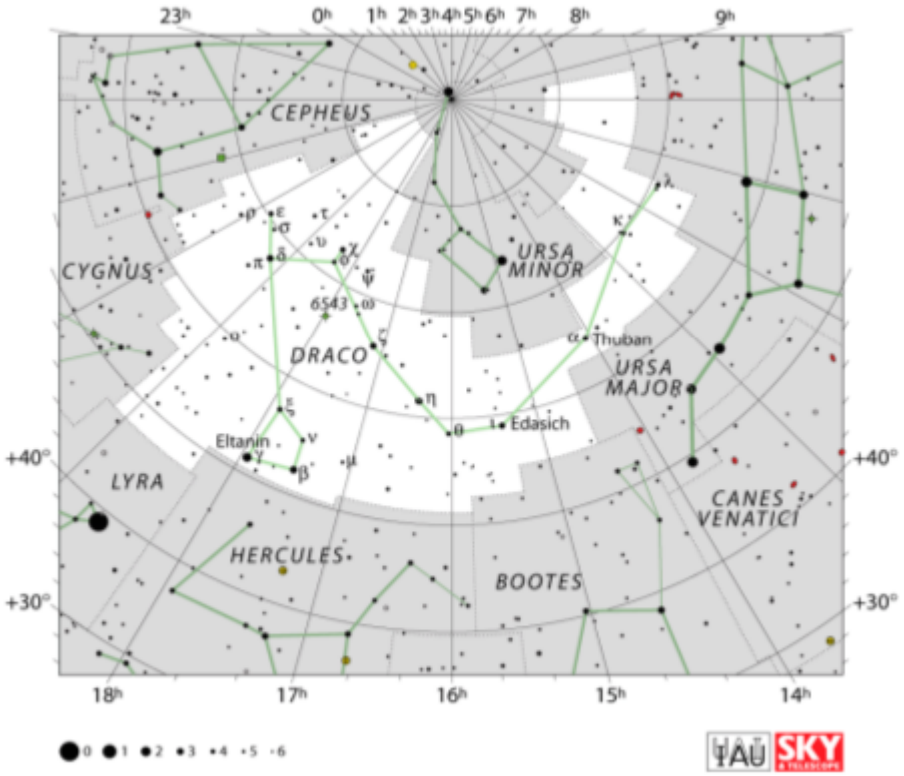

Fig. 5: Constellation Draco with the Current (2000 AD) pole star at NCP (http://www.iau.org/static/public/constellations/)

5.7 Precession

The constellation *Śiśumāra, Dhruva* and *Meru* have influenced the cultural practices of Indians for more than four thousand years. Nevertheless the inviolable effect of precession started taking its toll on the prime position *Śiśumāra* had as a constellation in the cardinal north direction during the 3rd millennium BCE. We have already seen mention of shifting and moving of *Dhruva* in the *Maitrāyaṇīya Āraṇyaka* in the 2nd millennium BCE. The *Mahābhārata*

revered the constellation, when King Drupada announced the marriage of his daughter Draupadī. The place for holding the famous archery competition was named *Śiśumārapura* and this was located to the *northeast* of the capital city.[78] The name and the specific mention of direction is an unmistakeable reference to the shift of the constellation towards northeast in the sky also. As the figure shifted far away from its prime north position, its shape altered to bring in new names such as *Nahuṣa* (serpent) and *Ajagara* (python) in the precession legends, in which the southern star *Agastya* (Canopus) also finds a role. The first recognition of the southern star and its identification with Sage Agastya in the Kurukṣetra region seems to have taken place around 3100 BCE.[79] With the passage of time the visibility interval of this star increased as also its altitude and importance of its first visibility in the Vedic annual cycle.[80]

It is interesting to note here that many of the legends connected with *Agastya* are about balancing the earth and rectification of the North-South direction. A popular astral legend appearing in the *Mahābhārata* is about King Nahuṣa seated in a palanquin being carried in the heavens by the Seven Sages and Agastya, on their shoulders, when Agastya was kicked by Nahuṣa for being too slow.[81] Agastya in anger curses the heavenly King Nahuṣa to lose his exalted position to become an ordinary *ajagara* (python). This legend is easily recognized as an allegory for precession being felt in the form of the *Śiśumāra* constellation losing its prime northern celestial position, along with star Agastya coming into prominence as a new bright star in the south. An interesting study of the religious influences of the Nahuṣa-Agastya legend has been carried out by Hiltebeitel.[82] According to him, the identification of the heavenly Nahuṣa with the constellation Draco was first proposed by two German scholars, both Adolf Holtzmann (uncle and nephew). The *Mahābhārata* also mentions the movement of *Dhruva* as a bad omen before the Great War.[83] This statement as also the most probable date of the war is in harmony with the middle of the 2nd millennium BCE, when due to precession α–Draconis was no more at the NCP.[84]

[78] ततः पुरजनास्सर्वे सागरोद्भूतनिस्स्वनाः। शिशुमारपुरं प्राप्य न्यविशन् ते च पार्थिवाः॥
प्रागुत्तरेण नगराद् भूमिभागे समे शुभे। समाजवाटः शुशुभे भवनैः सर्वतो वृतः॥ *MB Ādi Parvan* (Ch. 176 v. 15,16)

[79] Abhyankar K. D. *Folklore and Astronomy: Agastya a Sage and a Star*, Current Science, 89, pp. 2174-2176. 2005.

[80] Iyengar R. N. *Parāśara's Six Season Solar Zodiac and Heliacal Visibility of Star* Agastya *in 1350-1130* BCE. IJHS, 49.3, pp. 223-238, 2014.

[81] *Mahābhārata, Udyoga Parvan*, Ch. 17, v. 14-18. (BORI, Pune Critical Edition).

[82] Hiltebeitel A. *Nahuṣa in the Skies: A Human King of Heaven.* History of Religions. 16.4. pp. 329-350. 1977.

[83] ध्रुवः प्रज्वलितो घोरः अपसव्यं प्रवर्तते॥ Ch. 3, v. 17)

[84] Iyengar R. N. *Internal Consistency of Eclipses and planetary positions in the Mahābhārata*, IJHS. 77-115, 2003.

Among the three elements handed down by the Vedic *TA*, the visible entities were the star *Dhruva* and the constellation *Śiśumāra.* As these shifted position, the two receded from the day to day lives of common people, only to remain as legends. The third one namely the *meru* was always imaginary, but this withstood the passage of time best, providing the basis for the cosmological view of not only Hinduism, but also of Jainism and Buddhism and appears now all over India in temple architecture. The cosmology of the *Brahmāṇḍa* and other *Purāṇas* describing multiple ring shaped oceans, mountains and continental boundaries with distances stated in thousands of *yojanas* along with special numbers for the sun, the moon and planets sounds strange on first reading. However, recent studies by Kloetzli[85] on VP and by Thompson[86] on the *Bhāgavata*, show that *Purāṇas* present real three dimensional pictures projected on to a two dimensional plane, in layers, as in an astrolabe. A similar study on BP is desirable since, it is the source for all the ancient astral information that has been borrowed by the other texts either totally or with additions, deletions and distortions.

A difficulty one faces with BP is regarding its fixture in writing which must have happened in the early centuries of the common era. All *Purāṇas* basically claim to narrate ancient legends. Hence, one can object that BP text describing the *Śiśumāra* need not refer to Thuban as the pole star, but another one lying very close to the Pole. Such a possibility cannot be denied, since BP can be interpreted to state 15 stars, by counting the stars *Mārīca* and *Kaśyapa* separately. The only eligible candidate for this possible alternative identification of *Dhruva* is K-Draconis, which was nearest to the NCP ca. 1300 BCE at declination $85°13'$, violating the property of being seen to be fixed, even though it could still indicate the north direction. This possibility does not in any way affect the conclusions about *Abhaya-Dhruva* being known as a fixed star in the Vedic period. The other candidate suggested in the literature for being near the NCP is star *Kochab* (β-U.Minor). The nearest approach of this star to NCP was 83 degrees. This fact as well as the geometry of U.Minor, does not fit into the textual descriptions of *Dhruva* better than α–or K-Draconis. Even though BP has a stray statement (21.144) about the equinox being located at the beginning of *meṣa (rāśi)* and the end of *tulā (rāśi)* matching with the common era, there are several other observations that synchronize clearly with 2nd millennium BCE. In the identification of the equinox day, BP mentions that when the sun is in the first quarter of *kṛttikā* (Alcyone) and the moon in the fourth quarter of *viśākha* (α-Libra), the day and night are equal. Similarly when the sun is in the third quarter of *viśākha* and the moon is at the beginning of *kṛttikā* it is *viṣuvam* (equinox). This statement appears in several of the *Purāṇas* and hence cannot be ignored as spurious. This has

[85] Kloetzli W. R. *Maps of Time-Mythologies of Descent: Scientific Instruments and the Purāṇic Cosmograph.* History of Religions, 25,2. pp. 116-147, 1985.

[86] Thompson R. L. The Cosmology of the *Bhāgavata Purāṇa* (First Indian Edition) MLBD Publn. Delhi. 2007.

been discussed in detail in relation to other ancient astronomical statements by Koch,[87] to show that the record preserved in the *Purāṇas* holds valid for 1885–1645 BCE.

5.8 First millennium BCE

The very fact that BP first refers to *Dhruva* as a fixed peg to which the stars are tied, and next to a self-circling *Dhruva* driving the sun, the moon and stars, is evidence of correction to previous hypotheses made necessary due to the effect of precession. The further cosmological extensions with large spatial measure numbers must have been inspired by the imaginary *Meru*, at the tip of which *Dhruva* was taken to reside. This may be a development of the first millennium BCE, when there was no visible pole star at NCP. Texts reliably dateable to the first millennium BCE are very few. We have already seen that the *Gṛhyasūtras* dateable to c 500 BCE refer to the more ancient Vedic rites. These do not refer to *Śiśumāra* but by unbroken tradition the location of *Dhruva* must have been known to the faithful.

The *Atharvaveda Pariśiṣṭa* (*AVP*) an unaccented text, considered to be an appendix to the *Atharvaveda*, is available in 76 Chapters.[88] The work contains very ancient as well as not so ancient material, added most probably after c 500 BCE. The text refers to Pāṇini (*AVP* 43.4.16) and also to *dināra* a gold currency (*AVP* 36.26.3) of foreign origin which was in circulation in the northwest part of India at the turn of the common era. *AVP* has long chapters on stars, planets and comets like a *jyotiṣa-saṁhitā*. For the present purpose it is sufficient to note that Chapter 52 titled *Grahasaṅgraha* preserves a collection of names of stars and constellations other than the well known *nakṣatras* along the ecliptic. In this list the seven sages with names: Gautama, Atri, Vasiṣṭha, Viśvāmitra, Kaśyapa, Ṛcīkaputra and Bharadvāja, are said to be fixed in the north. This is followed by another star group fixed at the end of the middle sky, with unmistakable reference to *Dhruva* with *Śiśumāra* and a few others followed by *Viṣṇupada.*

शिशुमारेण सहिता ध्रुवेण च महात्मना। पुलस्त्यः पुलहः सोमो भृगुरङ्गिरसा सह॥
हाहाहूहू च विज्ञेयौ विष्णोश्च पदं उत्तमम्। मध्यान्तस्थावराणान्तु नियताविति बुद्धिमान्॥
AVP (52.10.4,5)

Some of the stars are named differently from the *Vedas* and the *Purāṇas,* but the constellation figure of *Śiśumāra,* the famous ancient star *Dhruva* and the station of Viṣṇu are the same as in the TA and BP texts. Some of the texts of the Jain tradition fixed within a few centuries after the advent of Mahāvira (599-527 BCE) contain information in the form of omens, anecdotes, and the calendar. The *Bhadrabāhu Saṃhitā* (ca. 300 BCE) mentions a comet

[87] Koch D., *Astronomical Dating of the Mahābhārata War.* Erlenbach, Switzerland. 2014. (http://www.gilgamesh.ch/KochMahabharata6x9_V1.00.pdf)

[88] *Atharvaveda Pariśiṣṭa* (Ed.) G. M. Bolling and J. von Negelein, Leipzig, 1910.

masking *Śiśumāra* as a bad omen.[89] A more detailed statement about a comet by name *Calaketu* rising in the west and moving north touching *Saptarṣi* and *Dhruva* before turning south, is available in the *Parāśaratantra.*[90] Such statements indicate that the constellation was variedly remembered, with or without *Dhruva.*

5.9 Common era (CE)

As we enter the common era, the nature of Indian astronomy, as is well known, changes its colour with emphasis on mathematics. The connection between the astronomical knowledge of the more ancient period and the *siddhānta* texts of the common era is not well investigated. There was no recognized star at the NCP during the common era, and we do not come across reference to *Dhruva* unambiguously as the pole star till the 15th century. But the terminology *Dhruvaka* for polar longitude is derived from *Dhruva,* interpreted as the Pole, an imaginary point on the sphere. *Meru* finds mention in the chapters on *Bhuvanakośa* but not *Dhruva* as a visible star at NCP. Brahmagupta (598–670 CE) discussing the rotation of the celestial sphere uses the phrase *dhruvayoḥ nibaddham,* meaning the two geometrical north and south poles of the sphere. The group of stars near the Pole was named *dhruvamatsya* (Polar–fish) and not as *Śiśumāra.* Bhāskarācārya (1114–1185 CE) in his *Siddhāntaśiromaṇi,* under *Bhuvanakośa* refers to the mouth and tail of this polar–fish and its synchronization with the sun rise and the sun set. In the 15th century the present Polaris or α-U.Minor had reached close to the pole at about 86° and a line connecting it to star *markaṭi* (β-U.Minor or Kochab) was recognized to rotate like a hand in a clock. This fact was used by Padmanābha to develop his astronomical instrument *Dhruva-matsya-yantra* for finding time as in a clock.[91]

5.10 Controversy among indologists

European scholars started taking interest in Sanskrit language, grammar and the Vedic literature from the 18th Century onwards. A topic of interest to many of these scholars was the date of the *Ṛgveda*, the most ancient literature of India, variously assigned from 4th millennium BCE to 1500 BCE. Jacobi[92] a German scholar of repute was a proponent of astronomy as a means of dating

[89] *Bhadrabāhu Saṃhitā* (Ed.) A. S. Gopāṇi, Sindhi Jaina Granthamālā. Bharatiya Vidya Bhavan, Bombay, 1949.

[90] *Parāśaratantra* (Reconstructed text with translation and notes) by R. N. Iyengar. Jain University Press, Bangalore, 2013.

[91] Sarma S. R. *The Dhruvabhrama-Yantra of Padmanābha.* J. Rashtriya Samskrita Samsthan, Vol. 6, pp. 321-343, New Delhi, 2012.

[92] Jacobi H. G. *On the date of the Ṛgveda,* (Transl. from German) The Indian Antiquary, 23, 154–159. 1894.

the Vedic culture. He pointed out the importance given by all the *Gṛhyasūtras* to show *Dhruva* as the pole star to the bride in the Vedic marriage rites. His argument was, since there was no pole star during the composition of the *Sūtra* literature, the composers of these texts should have known a star which was at the NCP in more ancient times, which can be none other than α–Draconis (Thuban). Jacobi somehow referred only to the late marriage codes for presenting his case. His opponents prejudiced as they were against dating the *Ṛgveda* to any period before 1500 BCE, treated *Dhruva* as an independent entity mentioned only in the *Sūtras* without any connection to the Vedic *Śiśumāra.*

Typical was the dismissal by Whitney[93] an American academic, when he wrote "…any star not too distant from the pole would have satisfied both the newly wedded woman and the exhibitor; there is no need of assuming that the custom is one handed down from the remote period when α–Draconis was really very close to the pole, across an interval of two or three thousand years during which there is no mention of pole–star, either in *Veda*or in *Brāhmaṇa.*" Keith working in India in the Colonial Office translated into English *Taittirīya Saṁhitā* and several other Vedic texts. Notwithstanding his knowledge of the country and its culture, he was derisive of the Hindu marriage ritual to comment[94] "…the argument from the pole star assumes an accuracy in the demands of the primitive Indian wedding ritual which is wholly unnatural." While criticizing the *Śatapatha Brāhmaṇa* text mentioning that the Pleiades do not slip from the east he wrote:

> a passage which consists of foolish reasons for preferring one or other of the *Nakṣatras;* we are in the same region of popular belief as when in the *Sūtra* literature the existence of *Dhruva,* a fixed polar star, is alleged.

As if not satisfied with the above arguments he added a footnote on page 79 of his monograph: "The pole star, *Dhruva,* appears in the *Gṛhyasūtras* only." It appears Whitney and Keith had no understanding of the *TA* text, assuming that they had read it. Keith coauthored a Vedic Index with Macdonell,[95] which is popular as a reference book even now. Under *Dhruva* there is reference to Jacobi and the controversy of this being the pole star. But under the entry *Śiṃśumāra/Śiśumāra* the word is taken just as an aquatic animal with no archaeo–astronomical recognition of a constellation. This is misleading, since even the Monier–Williams Dictionary of 1899 listed one of the meanings of *Śiśumāra* as: *a part of the heavens having stars of that shape.*

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[93] Whitney W. D. *On a recent attempt by Jacobi and Tilak to determine on Astronomical Evidence the Date of the earliest Vedic Period as 4000 BC.* The Indian Antiquary, 24, 361-369. 1895.

[94] B. Keith (1925) *The Religion and Philosophy of the Veda and Upanishads*, Harvard Univ. Press, USA

[95] Macdonell, A. A., & Keith, A. B. Vedic Index of Names and Subjects. J. Murray. London,1912.

6 Conclusion

Any attempt to trace the history of Indian astronomy cannot overlook the vast Vedic literature starting from the *Ṛgveda* and the *Purāṇas.* There are many numbers in the *Ṛgveda* and other texts, in the form of some types of time measures. These range from the short *muhūrta* (*RV* III. 33.5) to longer days, fortnights, months, years and even longer periods. *Vedāṅga jyotiṣa* (VJ) of Lagadha recognizes formally several other measures necessary for calendar calculations. The long count number 3339 is also a time measured in *tithi* linked only with the waning the moon. Since as per VJ there are 371 *tithi* in a solar year, the long count is a proxy for 223 lunation or 18 years. This is the so called Saros eclipse cycle, supposedly inherited by the Chaldeans from their Babylonian predecessors.[96] But 223 is only a derived number based on the more fundamental count 3339 and the time measure *tithi,* which number and word appear respectively for the first time in the *Ṛgveda* and the *Śatapatha Brāhmaṇa.* Hence the statement of Pingree that *tithi* and the VJ owe their inspiration to outside sources is unfounded.[97] The direction of transmission of this knowledge could as well have been from India to Chaldea.

It is also noted that the Vedic and the Purāṇic texts present the oldest description of a constellation named the *Śiśumāra* comprising of fourteen stars including the pole star. The identification and constraints for locating *Dhruva,* the ancient pole star, as vividly described in the *Taittirīya Āraṇyaka* of the *Yajurveda* and the *Brahmāṇḍa Purāṇa* are presented in this article from a chronological perspective. It is seen that the legendary *Dhruva* has left his imprint permanently on the sands of time, starting from 3200 BCE to the present day. The ancient Indian cultural practice of maintaining a spiritual dialogue between the visible sky and the earth (*dyāvā–pṛthvī*) has passed through the Vedic *Saṃhitā, Brāhmaṇa, Āraṇyaka* to the *Purāṇas* with many twists and turns and still later into the period of mathematical astronomy, preserving reference to two pole stars, a rarity for any culture. Scientific astronomers of the early *siddhānta* period scrupulously avoided the *Śiśumāra* of the *Veda* and the *Purāṇa* but retained the term *dhruva* to mean a fixed reference point, which terminology they needed for the coordinate *dhruvaka.*[98] But with passage of time, as star Polaris approached the NCP, the nearby group of stars was named *Dhruvamatsya* (Polar Fish) and the new pole star was kept at the mouth of the animal, in contrast to the ancient *Dhruva* placed at the tail of

[96] Neugebauer O., "A History of Ancient Mathematical Astronomy" Springer-Verlag, Germany 1975

[97] Pingree, D "Indian Astronomy," Proc. American Philosophical Society, 122, 6, pp. 361-364. 1978.

[98] Abhyankar K. D. *Dhruvaka–vikshepa* system of Astronomical Coordinates, Ind. J. Hist. Sci. 41, 151–157. 2006

the aquatic animal *Śiśumāra* (Figure 6)[99]. This ambivalence must have confused an outsider like Al-Bīrūnī since the orthodox Hindus whom he knew, must have held on to their belief that the pole star was at the tip of the tail of the constellation *Śiśumāra*, looking more like an alligator and not a fish. This amply demonstrates the long memory of the devout Hindus of their ancestral astral religion carried through centuries, attempting synchronization of their faith with the universal law as perceived in the *Vedas.*

The best example of how the Vedic facts are remembered is available in the commentaries on the *Viṣṇusahasranāma*, (Thousand names of Viṣṇu) which is a part of the *Mahābhārata.* All the three schools of *Vedānta*, following Śaṅkara, Rāmānuja and Madhva recognize this text as important for their tradition. All the three commentaries specific to the three schools interpret the 441st name *nakṣatranemi*, as a homonym for Viṣṇu, the controller of the *nakṣatras*, stationed at the heart-region of the (constellation) *Śiśumāra* quoting the Vedic and Purāṇic texts in differing details. Śaṅkarācārya explains that *Dhruva* sitting on the tail of this figure rotates the stellar circle. He quotes cryptically, the Vedic authority for his explanation as *viṣṇurhṛdayam*, which is the *Taittirīya Āraṇyaka* hymn (II.19).[100] This commentary has a gloss by Tāraka Brahmānanda Sarasvati a monk of the Śaṅkara tradition. His date is not exactly known, but he was after Sāyaṇa and hence can be assigned to 15–16 Century CE. We have already noted that Sāyaṇa, commenting on the *TA* hymn, says that one has to see the *Dhruva–maṇḍala* in the evening (see f.n. 58). One may wonder, which part of the sky was meant by the *Dhruva-maṇḍala*, since Polaris was approaching the NCP and *dhruva-matsya* was perhaps known to the general populace. We can surmise that Sāyaṇa, being a follower of Śaṅkara, would have known correctly the sky part of *Śiśumāra* with the last star being the *Dhruva* of the *TA* hymn. However, any semblance of doubt that may remain is set right by Tāraka Brahmānanda Sarasvati in his gloss. He not only elaborates on the original text and the commentary of his mentor but takes trouble to give the identification of the *Śiśumāra* in the sky. He first explains the meaning of this word as an animal figure looking like a Lizard or Iguana.

> शिंशुमारो जलजन्तुविशेषः सरटगोधाद्याकारः, तदाकृति ज्योतिश्चक्रं–शिंशुमारचक्रं तस्य प्रदक्षिणावर्तकुण्डलीभूतस्य उन्नमितपुच्छाग्रे व्यवस्थितो ध्रुवः॥

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[99] This figure is adapted from the link:
(Author: Tau'olunga June, 2006.https://commons.wikimedia.org/wiki/File:Precession_N.gif). The polar circle in blue colour shows the period in which visible pole stars are possible at the NCP. Negative years are BCE. Common era starts from year zero.

[100] *Viṣṇusahasranāmastotram* with the commentary of Śaṅkarācārya and the gloss of Tāraka Brahmānanda Sarasvati (Edited by R. Rama Sastry) ORI Sanskrit Series, 106, Univ. of Mysore 1961.

Next he says that *Dhruva* is residing at the base of the uplifted tail of this figure, leaving the faithful with no doubt as to where to look for the *Dhruva.* In passing we note that Al-Bīrūnī also refers to Draco as The Lizard.

We conclude that the Vedic people of the *Yajurveda* branch beheld the sky picture of a constellation named *Śiśumāra* (the modern Draco) with fourteen stars the last one being stationary without motion to be called *Dhruva* (α–Draconis) the pole star ca. 3000 BCE. They also preserved this information in their orally transmitted text *Taittirīya Āraṇyaka* which formed the basis for the *Meru-centric* astronomical models of the later *Purāṇas* and the still later cosmological speculations in the *siddhānta* astronomical texts.

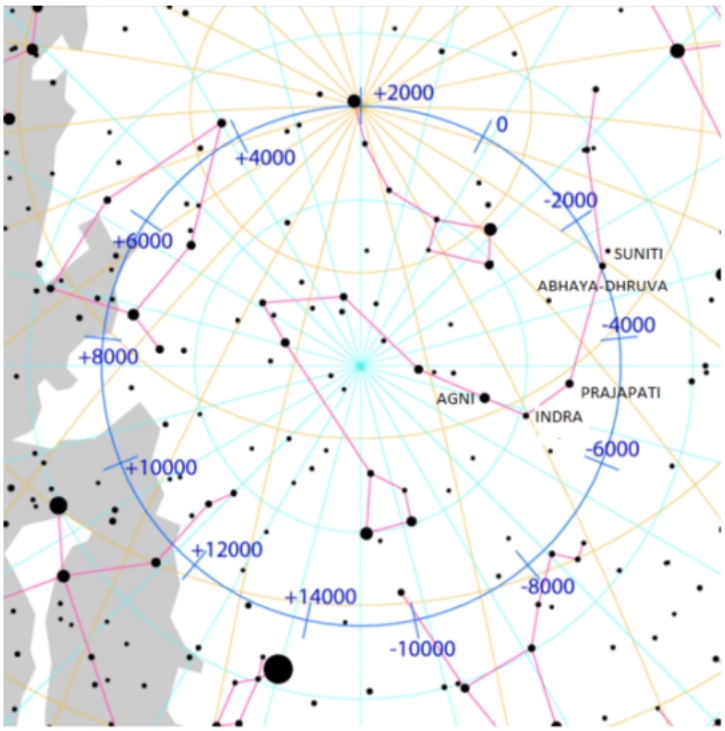

Fig. 6: The Path of the North Celestial Pole among the Stars due to Precession

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